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# THE LESSONS OF THE COLORADO CANYON.*

BY

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The Colorado Canyon is a superb illustration of the work of erosion in the plateaus of northern Arizona. It was first scientifically described about 50 years ago by Newberry, who clearly announced its normal origin; it was followed through its entire length in boats by Powell, who described many remarkable features in its history; it was thoroughly investigated by Dutton and elaborately illustrated by Holmes, whose report forms Monograph II of the United States Geological Survey; it is now visited by many thousands of tourists annually. There is, however, no general appreciation of the lessons that the canyon teaches. The usual visitor too often hesitates to regard the canyon as the work of ordinary processes, and inclines to attribute its beginning at least to a great fracture in the earth's crust, produced by some "convulsion of nature." This view has the aristocratic merit of antiquity, but no other. True, great fractures of the earth's crust do traverse the plateaus of northern Arizona; but there is no reason to think that they were suddenly produced; they do not appear as gaping fissures; and they all trend about north and south, while the course of the canyon, from east to west, is entirely independent of them. On the other hand, not only the main canyon, but all the numerous side

* Abstract of a Lecture delivered before the Society on April 20th, 1909, on the occasion of the presentation of the Cullum Geographical Medal, which was awarded to Professor Davis in March, 1908.



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canyons, branching again and again as they are gnawed back into the plateaus, bear every mark of having been gradually worn by the work of streams along their channels, and of weather on their walls. They are larger than most valleys, but in no other significant respect do they differ from the ordinary work of water and weather.

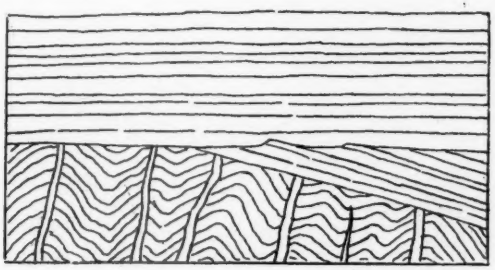
If the visitor is thus persuaded that the canyon is not the result of any sudden process, he may exclaim: "Can the earth be old enough for so enormous a valley to have been worn out by the slow action of ordinary processes!" And any one who sees the hundred miles of canyon length, its nearly a mile of depth, and its five or ten miles of breadth at the plateau level, must at first sympathize with this exclamation. Yet the most emphatic lesson that the canyon teaches is that it is not an old feature of the earth's surface, but a very modern one; that it is does not mark the accomplishment of a great task of earth-sculpture, but only the beginning of such a task; and that in spite of its great dimensions, it is properly described as a young valley. If one would appreciate the dimensions of a really great erosional work, let him imagine the processes by which the canyon has been produced to continue in operation until the main canyon shall slowly wear deeper and deeper, and the side canyons, increasing in length and width, shall consume the entire plateau, hundreds of miles north and south of the river, and thus the whole region shall be reduced to a featureless lowland but little above sea level. When that result is reached, we might well say that a vast work has been accomplished. It is in relation to that completed task that the work thus far accomplished is to be considered only as a beginning, and that the canyon is to be described as a young valley.

But the visitor who at the outset hesitated to regard the canyon as the slow work of normal erosive processes, and who, when converted to this belief, exclaimed that the erosion of such a canyon must have occupied nearly all the ages of the earth's history, will be little disposed to accept the possible realization of so much greater an accomplishment as is demanded in the reduction of the highland to a featureless lowland, little above sea level. He will be inclined to treat such a suggestion as a fantasy of the theorist, hardly worth consideration by the every-day, practical man; and if assured that logical reasoning can lead to no more important conclusion for the understanding of the canyon, he will imagine that the reasoning must be technical and recondite, beyond the understanding of ordinary mortals. It is the correction of these misapprehensions that make a visit to the canyon so repaying; for there better than anywhere else in the explored world is this fantastic suggestion con-

verted into reality, and all on evidence so simple that the ordinary traveller, endowed only with plain eyes and the usual portion of common sense, may appreciate the whole course of reasoning which compels the investigator to treat the canyon as a young valley. The canyon is only the record of the first few pages of a new chapter of earth history, which was not entered upon until seven other chapters, all recorded in or near the canyon, had been successively carried to essential completion.

Manifestly, the erosion of the canyon could not have been begun until after the making of the great plateau in which it is eroded. Let us therefore turn our attention from the canyon to the plateau, and particularly to the structure of the plateau mass, as exhibited in the great natural sections of the canyon walls. Here one may see the records of five of the seven chapters of earth history, and not far away one may study the sixth and seventh, each of which was enormously long as compared to the time required for the erosion of a mere canyon; each of which required the essential completion of a task, compared to which the canyon is only the beginning; truly a very respectable beginning, but nothing more.

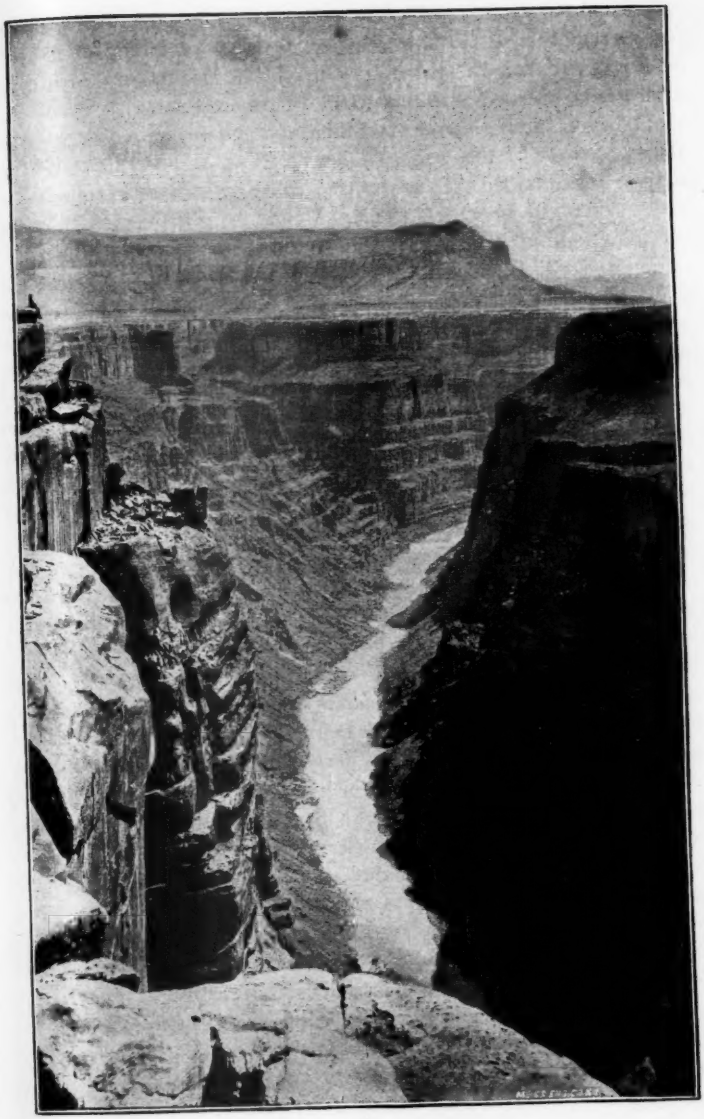
An inspection of the canyon walls shows us that they contain three different series of rocks; an underlying mass of deformed crystalline schists of unknown depth, penetrated by many dikes and veins; an inclined series of stratified rocks, some 11,000 feet thick, lying evenly on a smoothly inclined floor of crystalline rocks; and a horizontal series of stratified rocks, some 4,000 feet thick, lying on a nearly level floor which truncates the two older structures. We may speak of the oldest rocks as the foundation; of the youngest as




the plateau series; and of the intermediate mass as the wedge series, because of its position with respect to the other two. It is the resistance of the fundamental crystallines which determines the narrowness and the steep walls of the "inner chasm" where it is cut

through these deep-lying rocks. It is the horizontal attitude of the plateau series which determines the cliffs, formed by the harder members, to contour around the great promontories between the side canyons, and which determines the whole succession of cliffs and slopes, however irregular they may be in plan, to exhibit almost everywhere the same profile. It is the relative weakness of the wedge series which determines the widening of the canyon in the eastern part of the Kaibab plateau (some twenty miles east of the railroad station on the canyon rim), where these interpolated strata replace the resistant crystallines in the canyon bottom. The making of the crystalline foundation rocks must have involved an enormously long chapter of earth history, because their volume is very great and their accumulation must have required long-continued processes. Moreover, their crystalline texture can be accounted for only by supposing the former presence of a great superincumbent rock mass, so as to bury the parts now seen deep below the then earth's surface and subject them to conditions of great pressure and high temperature, under which alone the crystalline structure of their minerals and the wrinkled arrangement of their foliation can be accounted for. Surely, the production of this great crystalline mass with its superincumbent part must have occupied a long chapter of time. Next follows a chapter of erosion, during which the superincumbent part, of great but unknown altitude, was slowly worn away, grain by grain, to be deposited in the form of stratified rocks somewhere else; for only thus can the foundation, on which the next following wedge series lies, be accounted for. At that time, the now slanting foundation surface must have stood essentially level. The levelness of the foundation surface can be accounted for only by supposing that the former superincumbent part of the crystallines was worn down to a featureless plain; that is, the flat foundation gives us the realization of a great erosional work in the past, similar to the completed erosion of the plateaus in the future, compared to either of which the erosion of the canyon is only a respectable beginning.

It is proper enough for a visitor to the canyon to meet the first suggestion of the complete erosion of the plateaus, north and south, with incredulity; it is perfectly reasonable to doubt that so great an erosional task can be accomplished, as long as one has no direct evidence of the accomplishment of similar tasks. But on the other hand, it would savor of undue conservatism to persist in such incredulity after a good example of the actual accomplishment of such an erosional task, like the buried plains of erosion deep in the canyon



GRAND CANYON OF THE COLORADO.

Looking east from the foot of the Toroweap Valley. Depth at this point, 4,500 feet.

(From THE BULLETIN, Vol. 19, No. 2, illustrating "The Great Walled River," by F. S. Dellenbaugh.)

wall, has been pointed out. The great value of the canyon is, therefore, not only that it shows us the vigorous beginning of a cycle of erosion, recorded in the canyon itself, but also the end of a cycle of erosion, recorded in the structure of the walls.

The even surface of the crystalline foundation, on which the now slanting strata of the wedge series lie, is to be seen in section at various points along the canyon, separated by a score of miles; it is everywhere a very even surface. Hence, before the deposition of the now slanting strata of the wedge series, the surface of the foundation crystallines must have been an extensive plain. Whether the plain was the work of marine abrasion, as the waves of an ancient sea slowly cut away a bordering continent; or whether it was the work of subaërial erosion, which slowly wore down the hills until all the valleys coalesced in a featureless lowland close to sea level, we cannot now decide; but in either case the ancient destructive processes must have been continued through an essentially complete cycle of erosion. That is the main point.

The hearer of this explanation may, however, ask: Is this a geographical or a geological discussion? The question is pertinent; for the consideration of past processes is essentially geological, and it may at first hearing seem out of place in a geographical lecture. Nevertheless, it is really not irrelevant to introduce geological considerations into a geographical lecture, because geography is only the geology of to-day; and we cannot properly appreciate to-day without some understanding of the many geological yesterdays. Conversely, geology is only an integration of a long series of past geographies; and we cannot properly appreciate those yesterdays without a good understanding of what is going on to-day. It has too long been the habit of geographers and geologists to assume that they must live apart; and that geographical societies and geological societies have no work in common; but the modern understanding of geography corrects this older view, and leads the two sciences and the two groups of societies, in which the two sciences are cultivated, into more and more intimate relations. Hence I hold it to be entirely appropriate to introduce considerations gained from a study of the past in a lecture concerning the forms of the present.

There is an even deeper and stronger reason for the interplay of geological and geographical problems. It is the effort of many geographers to-day to give explanatory, rather than empirical, descriptions of land forms; that is, to treat each land form in view of its origin; to present it as the product of some process working on some structure; and in order to do this systematically, it has been

proposed that every land form should be described in terms of the structure of the mass of which it is the surface; of the process or processes by which the mass is carved; and of the stage reached by the carving processes, in view of the whole series of stages from the beginning when the land mass was first uplifted and exposed to carving, until the end when it shall be worn down to a featureless lowland. Evidently a systematic scheme of this sort cannot hope to find acceptance, until it is shown that the processes of erosion may really run all through the cycle of their changes, producing a systematic sequence of changing forms that ends in a plain of erosion; and it is directly here that the occurrence of the deeply buried, ancient surface of completed erosion in the canyon walls is so serviceable to geographers. The ancient surface gives them confidence that the scheme of the cycle of erosion is not merely a fanciful conception, but that it has had reality. It demands the former occurrence of a whole procession of changing forms, from the initial form produced by uplift to the ultimate form produced by downwearing. It gives warrant not merely to the acceptance of the scheme of the cycle of erosion as a well-substantiated theory, but even more to its adoption as a practical aid in the systematic description of existing land forms; for all land forms that we see must be now on their way through the current cycles of erosion on which they have entered. The fossil plain of ancient origin, long preserved by burial and now seen in section in the canyon walls, is therefore immediately pertinent to our description of the existing canyon as a young canyon; and the more clearly one conceives the origin of the buried plain, after reconstructing its several sections into a widely extended surface, the more fully will one feel justified in describing the canyon as a young valley.

Repetition is a good principle in teaching; and in this respect the canyon is a good teacher; for no sooner have we learned the lesson that the foundation crystallines represent two long chapters of earth history—one occupied in the making of their total mass, the other spent in wearing away a great part of it—than the lesson is repeated with just enough identity to make it convincing, and enough variety to make it interesting. The heavy strata of the wedge series, resting unconformably on the truncated structures of the crystalline schists, and more than two miles in thickness, must have required an enormously long third chapter of earth history in their making; for they represent the extensive erosion of some neighbouring land mass, and the bringing of its materials, grain by grain, from their source to their place of deposition. Then, after deposition, came the

tilting of the compound mass, and the erosion of its upper part, so as to truncate both the wedge series and its crystalline foundation in an almost level surface; and this destructive work must, in its turn, have required an enormously long fourth chapter of ancient time, compared to which the erosion of the canyon is but a beginning.

One may not in a lecture delay the attention of the hearers by attempting to give a realistic imitation of these long enduring processes of deposition and degradation; for the lecture would run through its brief course before any significant shifting of the sands in the geological hour-glass had taken place. But it is desirable that those of the audience who wish to approach nearer to a comprehension of the time-measures that are involved in cycles of deposition and of degradation, should take occasion, when they are out doors on some sloping hillside, to reflect a while upon the extreme slowness of the process involved; that they should strive to imagine the wearing down of the hill before them by the very processes of weathering that are silently at work before their eyes, until the hill shall be reduced to a lowland plain. At the same time, effort must be made to visualize the changes of form and their orderly sequence with the passage of time. Only after thoughtful meditation can one make a good step towards realizing the periods of time and the changes of form with which we are here concerned; only then can one begin to appreciate the geographical applications of the geological history recorded in the canyon walls by the even line of unconformity between the wedge series and the foundation crystallines, and between both of these formations and the overlying plateau series.

Thus the series of past events, accomplished before the canyon was begun, stretches out in a long procession; and the visitor, who at first thought that the erosion of the canyon must have occupied much of the history of the earth, begins to gain some better comprehension of the long vistas of early ages, all to be passed through before the canyon was thought of.

The unconformable deposition of the horizontal strata of the plateau series did not begin until the underlying compound mass was evenly truncated. The change then made from erosion in the fourth chapter to deposition in the fifth must be interpreted as due to a submergence of the worn-down region, so that it became the seat of deposition of the plateau series of strata, whose materials were furnished by erosion in some other region. Thus a fifth chapter of time is indicated, again very long in comparison with the time required for the erosion of the young canyon. This chapter in-

cluded the geological ages from Cambrian to Carboniferous, the first of which is represented in the lower members of the plateau series, and the last in the capping members which form the plateau surface of to-day. And now the visitor, perhaps becoming impatient at the long delay of these preparatory chapters, and wishing to hear something about the canyon, thinks that the opening of the next chapter will witness the uplift of the three-fold plateau mass, and the beginning of canyon erosion; but this is far from being the case. We must not attempt to hurry the events of the earth's history. An excursion northward across the plateau will bring us to a great group of retreating escarpments, formed on the outcropping edges of a heavy series of strata, some 5,000 feet thick, which overlie the plateau series; and these escarpments demand the occurrence of a sixth and a seventh chapter after the making of the plateau series and before the beginning of the canyon chapter; a sixth chapter for the deposition of the overlying strata on the whole of the plateau region; and a seventh chapter for their removal over thousands of square miles, exposing the present plateau surface as a lowland; and assuredly both of these chapters were long in comparison to the time required for the excavation of the narrow canyon. The seventh chapter may have begun with the erosion of a young canyon as long and deep and narrow as the present canyon; but it continued until the young canyon was widened to a broad valley, and until the broad valley expanded to an extensive lowland. Only then was the lowland uplifted to the altitude of the present plateau, and the erosion of the present canyon begun.

It is fatiguing, this long perspective of past time. The mind fails to grasp its duration, even if patient enough to enumerate its subdivisions. Yet an effort towards a comprehension of the geological history of the plateau region is profitable for the geographer, for only after some comprehension of this history, is he really prepared to enter into sympathy with the features of the land and the processes of land sculpture, and to regard the canyon as Mother Earth regards it. It is highly profitable to stand on the rim of the plateau and to peer into the depths of the canyon; to identify, as one may so easily, the several rock masses which, in their making and unmaking, represent the first five of the seven chapters of past history; it is better still to rove northward over the plateaus and see the great escarpments, stubbornly standing forth, yet inevitably retreating under the unceasing attack of the weather, as representatives of the sixth and seventh chapters; and then to return to the canyon and look into it once more, with deeper appreciation. It is

wholesome now to recall the impressions suggested by the first sight of the canyon; and to compare them with the broader understanding that has been gained by the thoughtful examination of the canyon walls.

The canyon teaches its lessons impressively because it is immense; it teaches them effectively because the great facts on which they are based are presented in grand simplicity. No one can learn these lessons without reaching a feeling of exaltation; no one can then fail to conclude that this earth which we inhabit is a working earth. If it be the province of the geographer to describe its present features, he must become something of a geologist before he can describe them sympathetically. It is really a moving picture that we see in a landscape; if it appears fixed, that is the fault of our too hurried, too thoughtless glance.

> The hills are shadows and they flow
> From form to form and nothing stands,
> They melt like mist; the solid lands
> Like clouds, they shape themselves and go.

Geographers must not content themselves with unappreciative empirical descriptions of land forms as fixed and finished, and leave to geologists and poets the fuller presentation of the greater truths concerning physiographic evolution. But geographers must have a care, so long as they are presenting explanatory geographical descriptions, to place emphasis on the forms produced by the processes, and not on the processes that have produced the forms. If in this lecture the attention of the hearers has been diverted from the present to the past, let it now come back to the present, and, with the first picture of the canyon again on the screen, let us recognize that all the accounts of the past as inferred from the records of the canyon walls have been introduced solely in order to give good warrant for describing the canyon as a young valley; we may call it a precocious young valley, if it is desired to emphasize its depth, but we must see that it is as yet far from being venerable.

# THE CONQUEST OF HUASCARÁN.*

BY

MISS ANNIE S. PECK, A.M.

To the adventurous lover of exploration among untrodden and unknown heights South America presents a field unparalleled save in the Himalayas. The Andes, however, lying within 100 or 200 miles of the sea and, with no political barriers, being far more accessible, it is remarkable that they should have received so little attention from mountaineers. Of the great number of peaks, more lofty than any outside of Asia, few names are familiar even to the inhabitants of their respective countries or to geographers anywhere. Indeed, many of the mountains have no names, or names that vary in different villages. Their heights are largely a matter of conjecture. While engineers have explored certain sections and miners penetrated here and there in search of precious metals, the region is sparsely settled and travellers are few. Hence, almost anywhere among the Andes, one may be on unfamiliar if not untrodden ground.

Although, for some years, Aconcagua has been supposed to be the highest mountain on this hemisphere, it seemed not impossible that in the great chain of the Andes some other might be found to overtop it when its altitude was more accurately determined. Such a change had occurred in the case of Popocatepetl and Orizaba in Mexico, to which my first expedition with a scientific motive had been directed. The observations which I made with a mercurial barometer on the summit of Orizaba, according to calculations by the United States Weather Bureau, gave this mountain an altitude of about 18,600 feet, Popocatepetl, until recently considered the higher, having an altitude of less than 18,000 feet.

As this climb was attended with no especial difficulty, it appeared that I could probably endure a still greater altitude. Accordingly,

*A Lecture delivered before the American Geographical Society on February 23, 1909. Through the courtesy of Messrs. Harper & Bros., a picture of Huascarán, which appeared with one of Miss Peck's articles in *Harper's Magazine*, is reproduced here.

my attention was directed to South America, not so much for the conquest of any particular mountain, as in the hope of finding one that would prove more lofty than Aconcagua. Mt. Sorata in Bolivia was first suggested to me as a possible candidate for this honour, and I determined to make an effort for its ascent. To verify the height of this great mountain, whose yet untrodden summit had been variously estimated as from 21,000 to 25,000 feet above the sea, to make meteorological, geological and any other observations possible in a brief visit seemed to promise a worthy contribution to science. After five years planning and fruitless endeavour, during which time an attempt on the mountain had been made by Sir Martin Conway, the way was suddenly opened and, on June 16, 1903, I sailed from New York with two Swiss guides and a scientific gentleman in quest of my long-desired goal. We carried a number of instruments: two mercurial barometers, one made especially for me reading down to ten inches, two hypsometers, two aneroid barometers, three hygrometers, a transit instrument, clinical thermometers, a sphygmograph to ascertain the strength and character of the pulse, and a sphygnomanometer to measure the blood pressure. Further, we prepared to experiment with the use of oxygen, carrying materials for its manufacture and large rubber bags to contain the gas. We were otherwise amply provided, especially against the cold, which I feared more than anything else. With such equipment and assistance I felt no misgivings as to the result, as hitherto I had always been favoured of fortune and my every undertaking of importance had been crowned with success. What, then, were my feelings when those three stalwart men turned away from the foot of the mountain, simply because the Indian porters refused to go up! Overwhelmed with mortification and disappointment, I was compelled to return, having accomplished practically nothing, except to confirm in their opinion those who had previously regarded me as insane.

It was impossible to drop the matter there. With heartfelt gratitude to a few residents of my native city, Providence, who made a second expedition possible, I set forth again, on June 21, 1904, alone. Accompanied by an Austrian, Mr. Victor Sintich, resident in La Paz, and one Indian, I attained a height of approximately 20,500 feet on Sorata, being again compelled to retreat simply because my companions, under most favourable conditions, refused to proceed farther.

Meanwhile, I had become convinced that Mt. Sorata was not so

high as some persons had supposed.* Mt. Huascarán† having in 1903 been called to my attention by Mr. Lucio R. Landerer, a Peruvian engineer, as the loftiest of the Andes, with an altitude, according to his measurement, of 25,000 feet, I now turned my steps thither. Disembarking at the small port of Samanco, Peru, about 200 miles north of Callao, one pursues his way on horseback 90 miles over the Black Range, down to Yungay at the foot of the mountain. We found at Samanco saddle horses and baggage mules which had been sent 20 miles to meet us from the sugar plantation, San Jacinto, through the kindness of Señor A. B. Leguia, now the honoured president of the Republic. The next afternoon we rode ten miles to the village of Moro. Thence it is, to the unpractised horseman, a long and fatiguing day's journey of 30 miles to the residence (altitude 12,000 ft.) of a Scotchman, Mr. John B. Bryson, owner of what is, perhaps, the richest silver mine in this the richest section of Peru. Two hours farther is the top of the Pass (14,500 ft.) in the Black Range, whence one looks down into the beautiful Valley of the Santa River, the largest in Peru flowing into the Pacific Ocean.

This Huailas Valley, through which the Santa flows, should soon become famous the world over, presenting, as it does, an extraordinary combination of attractions: a scenic splendour beyond that of Chamonix and mineral riches rivalling the Klondike's, for these mountains are veined with gold, silver, and copper, as well as the more useful if plebleian coal. This valley, in the Department of Ancachs, is 9° south of the Equator between the Black Cordillera on the west, here having an elevation of from 15,000 to 18,000 feet, and on the east the far more imposing White Cordillera, a row of snow-clad giants, stretching from north to south, as far as the eye can reach, with altitudes of from 20,000 to 24,000 feet. The serrated wall rises from 12,000 to 16,000 feet above the valley; massive brown buttresses below; higher up, tall rock cliffs and all along white peaks

*According to a triangulation made by Dr. W. G. Tight, a member of my first expedition, the altitude of Sorata is 21,300 feet.

†In regard to calling the mountain Huascarán, for which I have been criticised, I may say that I used this name, in spite of seeing Huascan on the maps, because every one in the vicinity calls it so. Mr. Bryson, who has lived near by more than thirty years, wrote that he never heard it called anything else. Señor Arturo F. Alba of Caraz, editor of *La Prensa de Huailas*, wrote me: "The beautiful mountain above the city of Yungay is called Huascarán. At no time has it ever been called Huascán except by mistake. When Señor Raimondi visited Yungay, not understanding Quichua, he mistook the true name Huascarán for that of Huascán."

It is obvious that, from Raimondi's error, the mistake was perpetuated upon other maps and was current even in Lima. However, the Peruvian Government in presenting me, at the instance of President Leguia, with a gold medal commemorating my achievement, has had engraved upon it the name Huascarán. The United States Geographic Board, April 7, 1909, decided upon the name Huascarán in place of Huascán.

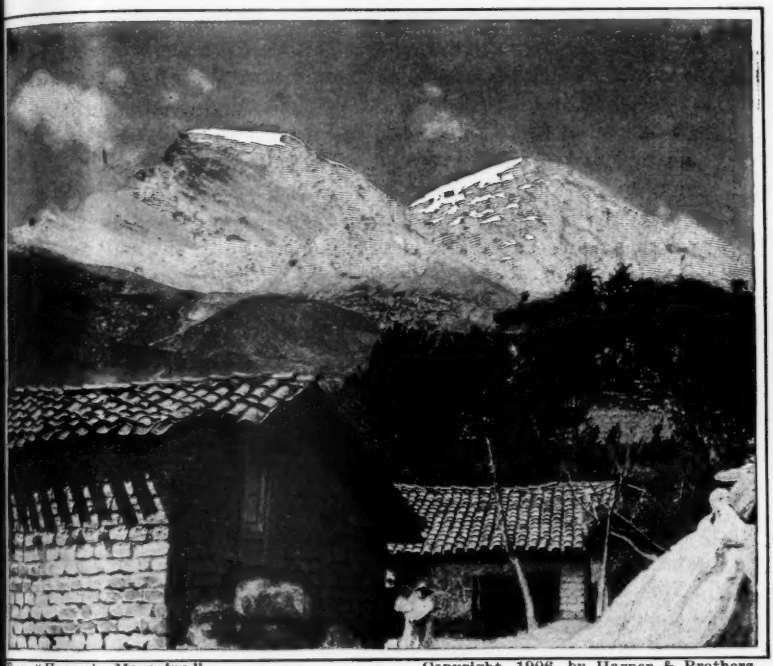
of dazzling splendour varying in outline, but many so sharp and sheer that it seems strange that the snow has not slipped away, leaving their heads and faces bare.

In the town of Yungay, on my several visits, I was most hospitably entertained by the Vinatéa sisters, and was aided in procuring Indian porters by Señor Ildefonso Jaramillo. Nearly 16,000 feet above the city tower the twin peaks of the magnificent mountain Huascarán, Yungay itself having an altitude of 8,300 feet. The fact that 9,000 feet of snow must be surmounted, and that the real climb begins only when one has surpassed the summit of Mont Blanc rendered its conquest an undertaking of great difficulty and hardship. In this, it is very different from Aconcagua, which, though much farther from the Equator, and with a reputation of greater altitude, possesses no such vast extent of snow-field and glacier, so that any one who is able to endure the rarity of the air, may walk without danger over ashes, rocks and streaks of snow quite to the topmost ridge. In 1904, the immense glacier on the west face of Huascarán was so visibly and terribly cut by a multitude of crevasses that it seemed impossible for the most skilful, much less for men absolutely inexperienced, to find their way through such a maze. Accordingly, I made a reconnaissance on the east side of the mountain, passing over at the north of Huascarán by the splendid Llanganuco gorge, four miles in length, a quarter of a mile in width, with perpendicular cliffs on either hand, at one point rising to the summit of the north peak 12,000 feet above, the altitude of the gorge being approximately 12,000 feet. At one point a beautiful green lake covers almost the entire width of the valley.

East of the White Cordillera we found a complex group of other snowclad peaks with steep and lofty walls of rock and ice. Pursuing our way up a valley to the southeast, we then turned to the west along a narrow defile towards Huascarán. For several days we toiled upward, though I soon saw that this side was steeper than the other. Either summit could be best attained from the saddle; but the part of the mountain below this was so swept by immense avalanches that an attempt here would have been foolhardy. Accordingly, we climbed the rocks of the north peak till further progress was prevented by a much crevassed glacier at a height of, possibly, 19,000 feet, and then returned to Yungay.

Although it was already October and altogether too late in the season, I now made an attempt on the west side, mainly to see whether the glacier was as bad as it looked and whether the Indians would venture upon the ice and prove of real service. At first the

glacier seemed easier than it looked from below, but presently there was a change. For two hours we wandered in the midst of a labyrinth of crevasses, ice walls, and pinnacles worse than anything I had ever seen in Switzerland. In the afternoon a snowstorm compelled an early camp. Though it was hot in the middle of the day, I was cold at night, even in my sleeping bag. It seemed cruel to ask the thinly clad peons to spend another night on the ice; so in



From "Harper's Magazine." Copyright, 1906, by Harper & Brothers.

MOUNT HUASCARÁN.

the morning I returned, rather well pleased at having learned that some of the Indians would venture upon the ice and that two had shown considerable skill and courage.

Although the assistance of Swiss guides was obviously desirable, not having sufficient funds to obtain these, in 1906 I again went down alone, hoping that earlier in the season with the ice in better condition and with the same companions as before, for whom I carried ample equipment, clothing, climbing-irons, etc., I might reach the top of the saddle, perchance the summit. But, unfortunately,

on arriving in Yungay, I found that the two best men had gone away to work at the Islands. The porters who accompanied me on the first attempt, after one night on the ice, refused to proceed farther lest they should be changed into stone; while on my second attempt the cholos from Carhuaz not only were lazy but drank the alcohol which was needed for fuel, so that after two nights on the ice it was necessary to retreat.

Convinced that nothing could be accomplished on Huascarán with the assistance of the natives only, I decided to visit Cerro de Pasco, hoping that some of my compatriots there might like to join me in an expedition. Although I was here so unfortunate as to have several ribs broken by a fall from a mule, eighteen days afterwards, I set out on a horseback ride for some mountains to the west, supposed to be 90 miles distant. The bad condition of the snow compelled us to turn back a little below the summit of the highest peak of the Raura range, which I estimated as having an altitude not much above 19,000 feet, a mere guess. This snowfield, of great extent, covering nearly the whole slope of the mountain, possesses especial interest in being the real origin of the Amazon, since the source of the Marañon, the larger of the two rivers which unite to form the Amazon, is a small lake a short distance below the glacier. This was a charmingly picturesque region of pellucid lakes, snow mountains, and splendid rock peaks. One of the latter we ascended, to me a delightful climb, crowned by a wonderfully beautiful view. I was pleased, indeed, at last to have made a first ascent of something. Though from my hypsometric reading it was not much above 16,300 feet, I was much happier here than when I attained the summit of Huascarán.

On June 27, 1908, I sailed, for the fourth time, from New York, now accompanied by two Swiss guides, just arrived from Zermatt, whom Dr. Alexander Seiler had kindly engaged for my expedition. On August 6 we set out on horseback from Yungay, as usual spending the night at a gold mine, Matarao, about 2,000 feet above. The day following we advanced to the snow line, 5,000 feet higher. At our first camp on the ice, not above 16,000 feet, Rudolf Taugwalder suffered from mountain sickness and felt obliged to return. With one Swiss guide and two porters only, our progress was slow, as the three men, in order to transport the baggage, were compelled to go over the ground twice, while I felt obliged to carry the mercurial barometer. A week after leaving Yungay we encamped at the top of the saddle. The next morning, Saturday, about 6 o'clock, we set out for the summit of the north peak, the other appearing

impossible. As Gabriel, my other Swiss guide, was obliged to cut steps a good portion of the way and then hold the rope for me, we were still, at 2.15 P. M., he thought, two hours below the summit. To go on, he said, would be a risk; I believed, a great one, as Thursday afternoon Gabriel had said he was almost finished. I thought it better to return alive than to reach the summit and slide down 4,000 or 6,000 feet; so the descent was begun. Before dark the tent was reached, when Gabriel and I threw ourselves headlong upon the blankets. I soon revived and called for snow to make tea, but Gabriel did not move for an hour and a half, and then was too tired to eat, which confirmed my opinion that I had been wise in not proceeding farther. The steps being already cut, it seemed that after one day's rest we might be able to repeat the ascent with greater rapidity. The Indians consented to do so; but, on Monday morning Gabriel, who had continued much prostrated, declared himself unable to go up. Our food was nearly exhausted, so, after nine nights on the snow, I was compelled to return with my task still unfinished.

We were greeted with much enthusiasm in Yungay by many who had feared that we were dead. A day's rest and I began planning for another attempt. "Do you *want* to go again?" they said. "No," I replied. "I don't want to go. I have *got* to go." On the way down, a sack containing the oil stove and a borrowed Eskimo suit had disappeared in a great crevasse. With difficulty the former was replaced by one procured from the neighbouring town of Caraz, probably the only oil or alcohol stove in the valley.

Ten days after my return I again set out with the two Swiss guides and four porters. Entering upon the glacier at the early hour, for us, of 7.15, the porters wearing climbing irons which the Swiss preferred to dispense with, we found the snow in better condition than before. With a more favourable starting point and no double work, we arrived in two hours at the site of our previous first snow camp. We soon pushed on to the second, and in the afternoon continued almost to our previous fourth camp, pitching the tent well up between the peaks at the foot of a more than perpendicular ice wall.

The following morning we began our work with the ascent of a very steep slope concluded by a perpendicular wall of blue ice, where Gabriel spent some time hacking out steps. Soon after, we arrived at the foot of the great wall, which stretched nearly all the way across the saddle. Here were yawning crevasses, ice falls, tremendous caverns, great hollows, everything that could be fabricated

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out of ice and snow, far surpassing in magnitude anything I had ever seen elsewhere.

Presently we arrived at the more solid and steeper part of the wall, averaging, Gabriel said, 80° or more. It lacked little of the perpendicular, being as steep as the upper part of the Fünffinger-spitze by the Daumen-scharte route. Thankful was I to reach the top in safety, knowing that the rest of the way to the crest of the saddle was comparatively easy.

Yet, in this easy part we had an adventure, one of the porters on the end of the first rope going through a snow bridge. Rudolf and I holding the rope, he did not go far and, with the help of the other rope, was soon hauled out, but without his pack, which Gabriel subsequently recovered, climbing down after it into the crevasse, fortunately not a very large one. Before dark, in unprecedentedly cold and wintry weather, we arrived once more at the top of the saddle in two days from the snow line, as I had hoped, with Swiss guides, to be able to do.

For hours I laboured with the stove to obtain hot soup for supper and tea for our ascent next day, as usual, long after the others had gone to rest. There was a strong wind at night, and, in the early morning, I advised waiting over a day till the wind should abate; but both guides urged going on, asserting that there might be less wind higher up. At 8 o'clock we set out, after the first hour making a traverse to the left among seracs, crevasses, and appalling slopes, ever gradually going upwards. Onward for hours we pressed, Gabriel cutting steps ahead, while Rudolf held the rope for me so that there was no delay. We paused a few moments for rest and luncheon, but were too cold and tired to eat the meat which had frozen in the rück sack as had also the tea in the water bottle. Later Rudolf declared himself unable to proceed, but having adopted Gabriel's suggestion that he leave behind his rück sack, he continued with us. The latter part of the way was especially steep. All were suffering from cold and fatigue, so that frequent halts for breath were needful. At last, rounding an apparent summit, we found a broad way leading gently to the topmost height. Here the wind was stronger, and I suddenly realized that my left hand was freezing. Rudolf had carelessly lost one of my fur mittens below, so that on this hand I was wearing two woolen mittens and one half mitten. Twitching these off, I found my hand nearly black. I rubbed it vigorously with snow, so that it soon began to ache, but it would be sure to freeze again. A poncho which I had asked Gabriel to bring up now proved my salvation. Putting this on, I remained

fairly warm to the end. A short distance from the top we attempted to take observations with the hypsometer, but on account of the wind, were unable to light the candle. Gabriel said, after striking twenty matches: "We must give it up." Sadly I packed away the instruments, as I had counted on obtaining the height of the mountain. To break, perhaps, the world's record and not be able to prove it was a great disappointment, but to return alive seemed still more desirable.

On reaching the goal, my thought was: "I am here at last, but shall we ever get down again!" After taking pictures in four directions, as it was now 3.30 P. M., we turned to descend. At first we made fair progress. Presently I saw something black fly away: one of Rudolf's mittens. I learned later that he afterwards lost the other. The slopes, mostly from 40° to 60°, were of hard snow as smooth as glass, so that steps had been cut nearly all the way; but these were small and for the descent seemed too far apart, especially after dark. On account of having had one foot frostbitten on the previous ascent, I had not worn climbing irons. Now, too late, I regretted their absence. After dark the little moon seemed always at my back, casting a shadow over the steps in front which my poncho occasionally concealed from view, so that I missed the step and slipped to a sitting posture. Then to my horror I began to slide, going down on a traverse 15 or 20 feet as far as the rope allowed. Several times I slipped, once pulling Rudolf too, so that Gabriel's strong arm alone saved us from destruction. From the beginning I greatly feared the outcome. Rudolf confessed later that he did not expect to get down alive; but Gabriel said he never despaired except when Rudolf slid also, when, for a moment, he thought we were all lost. But knowing it was life or death, he stood firm till Rudolf could recover himself.

It seemed that the way would never end, but at last we came out from among those horrible abysses to the slope above the tent, where I could safely take a sitting glissade. We arrived at the tent at 10.30 P. M., too tired to eat or sleep, but thankful for rest and shelter. Poor Rudolf's hands were badly frozen. He rubbed them weakly with snow to little purpose. The wind blew hard all night and in the morning no one proposed descending. Gabriel went up after the alcohol, which had been carried some distance, for fear the Indians would drink it, but he failed to find it, so for two days we were without fire or water.

On Friday morning we started downwards. On reaching the great wall our three ropes, measuring 180 feet, were tied together,

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but did not reach nearly down, only to a convenient ledge of ice. We descended one at a time, Gabriel with one of the Indians paying out the rope from above. We reached the rocks before dark, thankful, after two days' abstinence, to have plenty of water to drink. After our return to Yungay, the condition of Rudolf greatly marred our triumph. As he was unable to be moved, I left him (with Gabriel) under the best possible medical care, but later it was necessary to have part of one foot amputated, most of his left hand and one finger of his right: a sad result of mountain-climbing, but due to his own carelessness. To the other guide, Gabriel Zum Taugwald, too much credit can not be given. He was evidently the stronger, and was willing to use his strength to the utmost; in both ascents bearing the brunt of the work and proving himself a faithful and skilful guide, unusually competent for very high climbing.

In regard to the height of the mountain, an American engineer who was in Peru thirty years ago has written me that Raimondi's figures were not considered very accurate. It is well known that widely different measurements by triangulation have been made of Mt. St. Elias, Orizaba, Aconcagua, Sorata, and many other mountains, so it can hardly be taken for granted that one particular triangulation of Huascarán is absolutely correct. Equally, one mercurial or hypsometric observation may not be. However, simultaneous observations taken at Yungay by Francisco Handabaca with hypsometer and by myself at the top of the saddle with mercurial barometer and hypsometer, as calculated by Prof. H. C. Parker of Columbia and by Prof. C. F. Marvin of the U. S. Weather Bureau, give the height of the saddle as 19,600 feet.

From the fact that on the summit of El Misti, most accurately measured as 19,200 feet, the hypsometric reading was 81.6 C., while on the saddle of Huascarán it was 81.02 C., I had believed this altitude to be nearly or quite 20,000 feet. The reading of the mercurial barometer, at practically the same time, was 14.56 inches. Temp., 22° F. In the opinion of the guides, who have had much experience where the altitudes of hut and summit are known, and of myself, the height of the peak above the saddle is about 4,000 feet. From the hills above Yungay, this height appears little less than that from the snow line to the saddle, from our observations, about 5,000 feet. Various photographs also clearly show that the height of the peaks above the saddle cannot be very much less.*

*Professor G. Steinmann, of the University of Bonn, who spent five months in Peru (May-September, 1908) for geological study, quotes for Huascarán (*Gaea*, March, 1909) a height of 6,721 meters or 22,045 feet. He adds, however, that the mountain has recently beeen ascended by an American lady, and if her estimate of its height is correct, it is probably the highest summit in the western world.—EDITOR.

Huascarán is surely higher than Aconcagua, which the latest authorities give as 22,812 feet, and is thus the loftiest mountain known on this hemisphere. If future triangulations, or observations made on the summit of the south peak, which is probably a trifle higher, should prove, as I have hoped, the altitude of Huascarán to be 24,000 feet, I shall have had the honour of breaking the world's record for men as well as women.

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## THE PLATEAU OF THE SAN FRANCISCO PEAKS IN ITS EFFECT ON TREE-LIFE.

### PART II—(CONCLUSION).*

BY

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### III.

Looking south from Observatory Mesa over a wide stretch of the once primeval forest one's vision is barred some fifteen miles away by Mormon Mt., which, like a huge porpoise with snout pointing to the east, lies stretched along the horizon. The blue of distance invests it with a height it does not properly possess; for the barometer, as it proved later, accords it but 8,400 ft., or 1,400 ft. above the pine-clad plateau upon which it rests. Tree-covered to its top, the eye can distinguish vertical scars seaming its face, but no difference in the distant look of the trees themselves. On the north slope the snow holds longer than on the plain below and patches of it high up on the side send glints across the intervening air, well after the winter's sheet has elsewhere disappeared. Only upon the Peaks do such vernal lingerings find antiphonal response.

Alluring to the thought, it was to it that the second camping trip was made. The way thither lay through Clark Valley, so-called after John Clark, the first white man to settle hereabouts in 1876, when wild turkeys often loaded the trees and bear at times made him take to the trees himself. The road now is known as the Verde trail and is in places execrable beyond belief of a trail through an open forest until one had had experience of the mud here in spring, the ruts then made remaining stereotyped through the year. The travel-

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ler leaves this for one still worse a couple of miles from the mountain's base and shortly comes out upon Mormon Lake, a sheet of muddy water locally famous for its ducks in spring and autumn. Half-way down its western shore, a little valley marks the end of Mormon Mt. and a spring of water offers a good spot to camp at 7,150 ft. The names are relics of a not remote past. For this whole country was early colonized by Mormons, the chief of whom, one Elder Smith, was a fugitive ringleader of the Mountain Meadow Massacre and continued here his lawless career until he was shot some years ago by a victim of his cattle stealing at his ranch near Lee's Crossing.

A steep slope led from camp to the summit of the mountain, a nearly flat top a mile long, devoid, however, of any signs of a crater, but ridged in places like a wisdom-tooth. On its southeast side, up which the ascent was made, the first Fir, a Silver one, appeared at 7,750 ft. and the first Douglas Fir at 7,870 ft., both firs becoming more numerous and the pines less so as the height increased, though the latter contested still the southern half of the summit. At the summit a curious exception to the general choice of lightning showed in the person of a fine Silver Fir which had been wrecked by a bolt, though plenty of pine stood conveniently near. Quivering aspens here and there diversified the park-like summit in the glades, while, elsewhere, almost impenetrable thickets of gooseberry bushes with great red fruit occupied the bottoms. On the north face of the mountain, the gash of a landslide, one of the scars descried from the Observatory, offered an unobstructed view over the country below, and, the fulness of time having come for lunch, Doyle and the director sat down to drink in the scenery. Gazed from instead of gazed at, their standpoint gave a very altered look to the landscape, which now seemed utterly wild. Flagstaff had faded from sight, even the lumbermen's ravages no longer showed; only a tiny white speck flecked a distant mesa, which position assured them was the dome of the Observatory. In all this country dominated by the Peaks, it stood out sole token of man. That it alone of man's handiwork should thus show afar seemed curiously symbolic of its position toward the world at large.

After lunch the two further explored the top till they reached the end of the western side. On the southwest fell away a broad ravine filled with Silver and Douglas Firs. This the director descended to find the lower limit of both species in it at 7,800 ft. But upon the ridge-slope south of it he had to rise to 8,200 ft. before reaching them again. From comparison with the altitudes for the same

trees on the southeast face, it is evident that the southwest one is the warmer.

The next day, the two explorers set out to investigate some hills to the southeast of the lake. The nearest of them, a sharply conical summit, had Silver and Douglas Firs almost at its foot on the north and northeast at 7,350 ft., which thence climbed to the top at 7,920 ft., occupying the rocky apex there, but not descending at all down the southwest slope. Nor was Anderson Mesa, just eastward, a nearly level plateau at 7,700 ft., occupied by anything but pine (*Pinus ponderosa*) and White Oak.

SILVER AND DOUGLAS FIRS.
Hill south of Mormon Mt., 7,500 ft.

The day was September 28, and on the way up the hill Doyle killed a tarantula at 7,600 ft. The date is significant, because, though this great spider inhabits the country the year round it is never seen at any other time. During the months of September and October of this year three more specimens were captured on the ground right round the Observatory, members of both sexes apparently. During the rest of the year, you shall search for them in vain; a deprivation tempered by the fact that they then do not find you.

That afternoon, two of us went up the ravine behind Mormon Mt. on the south to look for a mountain lion seen by some others of the expedition the day before. It seems that the lion almost licked their hands and then ambled away. The present searchers could not find the place, still less the lion, but discovered that Silver Fir descended the north side of the ravine to 7,400 ft., 800 ft. lower than on the mountain side opposite.

How the northeast face of the mountain itself was circumstanced was shown the next day. Here Silver Fir came down to 7,200 ft.

SILVER FIR. (ABIES CONCOLOR.)

N. E. slope of Mormon Mt., 7,200 ft., standing a lonely outpost amid the pines.

and Douglas Fir to 7,370 ft. The Silver Fir proved in all this country to have a slightly lower range than the Douglas Fir, from ten to a hundred and seventy feet according to locality. But, what was peculiar, these two trees monopolized the Canadian zone here. Not a specimen of Rocky Mountain pine occurred in all its islets; in marked contrast to the state of things in the arborial islands fifteen miles away to the north.

## IV.

The next excursion was to Wing Mt., made directly from the Observatory; a crater, this, some five miles southwest of the Peaks. Wing Mt. is a nearly perfect cone, truncated in slant to the southwest where the original crater spilled its contents. On the north, its base lies at 7,600 ft. The explorers mounted by the northeast face through a grove of aspen to encounter the first Rocky Mountain Pine at 7,800 ft. on the slope and the first Douglas Fir at 8,020 ft. Both trees descended a hundred and fifty feet lower in the gullies.

WING MT.

Half-way up looking toward the Peaks.

Through their branches beautiful vistas showed of the flanks of the Peaks opposite, flecked with gorgeous golden gleams of the turning aspen scattered in patches upon them and the mountain's slope looked all the steeper for the framing it thus got; an effect the director first noticed on descending Fuji in Japan years ago when suddenly catching a glimpse of a lake below through cloud. The water seemed to lie tilted toward him at an angle of fully fifteen degrees. The summit of Wing Mt. is an almost circular rim hardly fifty feet across, and rising a hundred and fifty feet in its circuit from the southwest

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to the north, yet so evenly, a carriage might drive along it through the nearly treeless grass. The top at the north stands at 8,610 ft., while the survey cairn on the east is placed at 8,545 ft. Of the outer slopes the northern moiety is studded with fir, while the southern half is tenanted exclusively by yellow pine. On the inside, the slopes to the crater, perhaps a hundred feet below, are also entirely pine-clad except in the centre, which is only carpeted with grass.

Eastward of Wing Mt., across an arm of the Fort Valley, stands Crater Hill. Some miles away in an air-line the ramparts of the

DOUGLAS FIR.
Wing Mt., north slope, 8,000 ft.

two former volcanoes confront one another, while their vents discharged in opposite directions. Between the two the country lies at the general level here of the plateau, the neck of land connecting them, in the first government map, being a government monopoly. From Crater Hill, eastward, stretches its great lava flow, now a mesa five miles long by a mile and a half broad, on the eastern tip of which stands the Observatory. The altitude of this lava flow is 7,650 ft. where it abuts upon Crater Hill and 7,250 ft. where it ends abruptly at the Observatory. It discloses its own thickness, 350 ft., in the height of the edge of the mesa above the town. Composed

of a mass of malapais stones which age has partly buried in loam, it is tenanted by an open forest of yellow pine, very sparsely undergrown of grass. It is worthy of note that only its edges support a varied flora, either of flowers, shrubs or trees, its flower fringe being coincident with the strip that gives foothold to the oak.

In consequence of the founding of the Observatory and of the building of a road up to it from the town, a cart-track now traverses the formerly trackless length of the mesa; over which a rough drive of five miles takes one to the crater's foot. In the present instance the ascent was made from the southern side. This slope is tenanted like the mesa by yellow pines alone until within a hundred feet or so below the rim where, strange to say, there is a solitary specimen of *Pinus flexilis* at 8,150 ft. and an equally solitary one of Piñon at 8,200 ft. The *Pinus flexilis* is a sorry-looking individual, regretful apparently of having strayed round the corner; for a quarter of a mile away are many of its kind on the northwest and north slopes. The tree there tops the crater wall in company with the Douglas Fir at 8,300 ft. The wall dips slightly at the north to rise at the northeast into a buttressing peak, 8,330 ft. high, from the top of which both Mr. Lampland and the director could see with the naked eye not only the little white flag on the cairn of Wing Mt., three miles and a half away in an air line, but the pole from which it fluttered, a light gray stick, three inches in diameter and six feet high. This last came out by flashes much after the manner of the canals of Mars, so that we have here a maximum criterion of their width. For three and a half miles of air in the middle of the sun-heated day is a much more unsteady thing to see through than a vertical column at night.

## V.

### Ascent of the San Francisco Peaks.

It was mid-October when it came the turn of the Peaks to be climbed. It was high time. Long before this the first snow had fallen on them, but it had now begun to be permanent and to descend lower with each new fall. The slopes themselves were ablaze in patches with the golden tints of the dying aspen, the calling of the autumn from afar. Through some of these the ascent would lie; for the attack was to be made from the southwest side and the descent effected on the north, in order thus to explore the warmest and the coldest slope exposures. The usual climb is made from the southern face up which there is trail.

The exploring party consisted of a guest—a young journalist—the director, his man-servant and Doyle. On the afternoon of October 15, the start was made from the Observatory, and camp was pitched that night near Le Roux springs at the head of Fort Valley at an elevation of 7,380 ft. Above it rose the spurs of the mountain mass. Round the camp-fire the plan of action for the morrow was discussed. It was the purpose of the director to ascend Agassiz Peak first, continue thence along the ridge to Humphrey and from there to descend as nearly northeast as might be, while Doyle was to take the camp outfit round the mountain and meet the

DOUGLAS FIR (BOLE).
San Francisco Peaks, 8,700 ft.

descending party on the other side. A certain sheep-camp lay at about the spot where the mountaineers wished to come down, but it was far from certain where it was. As neither of the two parts of the expedition was properly acquainted with the position of the rendezvous, Doyle not having been there for many years and the others never, it was agreed that when Doyle reached this uncertain sheep-camp, if he ever did so, he should light a smudge for the others to steer by. To make this problematical meeting was imperative, as there were no houses upon that side of the Peaks. With

this pleasing doubt before them and clouds threatening the summits, the three pedestrians slept that night and set out the next morning.

The first hour saw them trudging up the outer spurs through the pine forest at a fairly steep incline for several hundred feet of ascent. At the top of the buttresses, the Peaks thus thrust out into the plain, they came upon the outposts of the Fir zone, a Douglas Fir or two and a Rocky Mountain pine. The height was 8,250 ft. Behind, in a little hollow, their deciduous accompaniment, the quivering aspen, shimmered in the faint breeze. Its leaves, now in their golden prime, made a glittering canopy overhead, yellow tingeing through orange to almost red at times, and a carpet no less brilliant below, as if Nature had run a carnival of riot the night before and strewn the ground with tree confetti. Pines still contested the soil up to the ledge overlooking the Waite Ranch (8,520 ft.); from the ledge, 8,670 ft., the fir zone definitely began.

Passing through some open glades to a spring and then up one of the ravines, the explorers came upon the first Silver Fir (?) at 9,350 ft. and the first Cork Fir at 9,480 ft. From the great height at which the former appeared, from the question-mark given its identification at the time, and, lastly, from the same doubt expressing itself when it was encountered on the descent upon the other face of the mountain, it is probable that the supposed Silver Fir was a Cork Fir and it will so be provisionally considered. The Cork Fir is a tree of high habitat, intermediate between the Fir and Spruce zones, though belonging properly to the former. It was found in this investigation only on the Peaks, but there both on the southwest and north outer slopes as well as everywhere at the proper elevation inside the crater. Its range on the outer southwest slope was from 9,350 ft. to about 10,700 ft.

It was hot here and the forest dense, so that one was shut in with the trees in spite of the slope. In the thickest part stood the lowest Engelmann Spruce at 10,230 ft. From this on it grew commoner, but was not joined by the Fox-Tail pine till just before the Cork Fir gave over, at 10,680 ft.

From 10,500 ft. to 11,500 ft. lay the Spruce zone proper, the open character of its trees on this particular slope and the vistas off giving one the impression of being on a mansard roof. The Spruce and the Fox-Tail pine shared the slope exclusively, the red next year's buds of the latter giving it a fictitious bloom. At 11,500 ft. the ridge came to an end and both trees became dwarfed, forming the Timber-line zone which straggled up to 12,080 ft. and there gave place to bare rock. The peak of Agassiz now came into view for

the first time since leaving camp and clouds close at hand could be seen to form and scurry over the summit from the east. Its rocky mass, patched with snow, stared the travellers in the face with a towering sense of desolation, the sky line above being formed of two steep ridges of ascending arête at right angles culminating in the peak, now visible, now not. Striking for the arête on the left the travellers eventually came out upon it at the point where the snow began. Here the view ahead opened before the climbers, to the dismay of the journalist upon whom the route yet to be traversed dawned for the first time in dispiriting apparition and who in conse-

INSIDE THE SAN FRANCISCO CRATER.

quence decided to forego Agassiz as he was very tired, preferring to circuit the peak to a lunch rendezvous on its northern face while the two others climbed the rocky talus to its top (12,340 ft.). Intermittent drifting clouds over the summit gave just a chance to heliograph the Observatory far below, eight miles away in an airline. From this vantage-point the eye got a superb view of the crater within and the walls enclosing it, especially the series of escarpments stretching north to Humphrey. The scene was desolate, enhancedly so from the grey fleeces of cloud that seemed to chase one another from the abyss out over the top and down the outer

slopes. Height flattened the lower reaches of the mountain till one had said the greater part of its mass was bare rock. It certainly seemed an inconceivable distance down to the spires of the topmost firs.

It was now 1 o'clock and the partial view of the long distance yet to be gone with an uncertain goal at the end tended to emphasize the inhospitableness of the surroundings. Nevertheless, the lunch amid the snow just under the lea of the crater-rim had a setting and a taste the best of cooks had envied. Then up and down along the rim the explorers proceeded, finding pretty little flowers in the crannies of the rocks and at a low part of the jaws at 12,050 ft. some dwarf Engelmann Spruce at the very crater's edge. Farther on a Fox-Tail pine, whose trunk measured 15 inches diameter, crouched at 12,020 ft. to get out of the wind. Upon this west slope the highest Fox-Tail pine stood at 12,080 ft., the timber-line, sparse as it was in occupants, reaching to about the same height on this whole side of the mountain. The view off was superb. The near foreground stood desolate to a degree, rocky ribs protruding amid heaps of broken slabs, but below that the evergreens, spruce, pine and fir laid a carpet of vert, splashed here and there with gorgeous gleams of gold and orange made by colonies of the quaking asp.

Deeming it easier, the journalist, taking the man-servant with him, skirted the summits some hundred of feet down, while the writer pushed upward to the top of Humphrey (12,610 ft.). Here the snow stretched continuous and upon it at the very apex of the peak showed the recent tracks of a chipmunk, going to the cairn which crowned it. It was probably a *Tamias Cinoreicollis* which according to Merriam is most common where the Pine and the Fir zones overlap, but climbs as high as the timber line. Quite a journey thence to the summit and amid the snow to boot! What an immense height it must have seemed through the lenses of its little eyes unless its brain mechanism be very different from man's. A couple of eagles soaring rythmically round, a stone's throw below the peak, was the only present evidence of life.

A snow-wrapped arête twenty feet wide led down nearly north, the snow making excellent glissades, sixty feet at a stride; a luxury of progression, especially after the long toil up. From above, it looked to be half-way to the foot before the snow came to an end, but the shoulders below rose as one descended, the bottom still lying a far distance off. On the ridge the timber line was reached at 11,960 ft. Upon the northwest side of the ridge opposite, to the east, the trees seemed to start a little lower and we may therefore

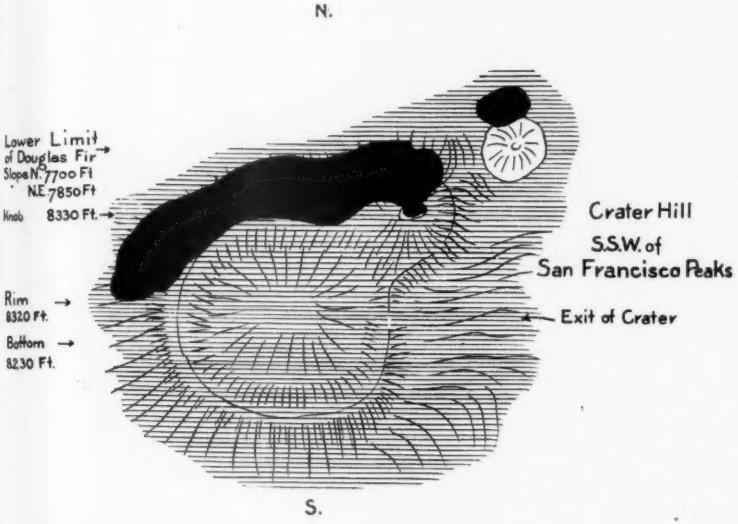
take the coldest timber-line at 11,850 ft. The Fox-Tail pine on the north slope out-climbed the White Spruce by some fifty feet. As a tree, the Spruce first stood up at 11,480 ft., and the Fox-Tail pine stood up with it. The red buds of the coming year on this tree were, next to its fox tails, its most striking feature. It is well named, and so like are its twigs to a fox's brush as to make up in part for the lack of animal life. For no creature, except the eagles, was visible from start to finish.

At 10,840 ft. the Cork Fir appeared again to continue down to 9,510 ft., while the Silver Fir appeared once in the note-book with a question mark at the latter elevation. On this side of the mountain the Rocky Mountain pine was first met with on the descent at 10,760 ft. and the Douglas Fir at 10,160. Meanwhile nothing could be descried of the sheep-camp nor even of its probable location, several natural clearings answering equally well the description given of it, and affording no further sign of domestication as descent brought them nearer. The explorers were beginning to stare a homeless night in the face when a cry from the journalist announced a find as he pointed to a faint curl of blue smoke in the great forest below. The explorers made no doubt that this was their goal because of some things that looked like tents near it and headed down in its direction. The trees then shut out the view, so timbered were the slopes, and they had to steer for it by occasional glimpses of the distant cones below to the north.

Meanwhile, the first yellow pine had been met at 9,000 ft. and soon the yellow pines began to increase and the Douglas Firs and Rocky Mountain pines to thin until, at 8,780 ft., the last of the latter bade goodbye just as the party debouched from the ridges out upon the gentler slope of the plateau. It now started to drizzle and darkness came on apace. A cart-track, it was known, ran round the mountain to the sheep-camp, to strike which was now their endeavour. It shortly grew so dark that unless they met it soon there was small chance of their recognizing it when they did cross it. A few more minutes would settle any possibility when, by good luck, they struck it. Turning along it to the right, they tramped steadily on in the rain for what seemed an excessive distance, when one of the party caught sight of a will-o-the-wisp light through the timber which eventually proved to be the camp-fire. They arrived to find it, as well as the sheep-camp, deserted. Nothing was to be seen of Doyle, though the wagons were there, the horses tethered and the tents pitched. Presently a distant shot, and then another, told of Doyle's distress. He was out hunting them. But they had no gun and

their answering shouts failed of response. To hunt Doyle in their own tired and soggy state seemed supererogation. There was nothing for it but to make themselves at home until such time as he should come in, disheartened; which eventually he did, to be astonished but consoled.

The following morning the journalist and the director started from the sheep-camp at 8,460 ft. and drove westward round the mountain to Little Spring and thence northwest to Walker Lake. The cone of this old crater is peculiar for its very symmetry; look-

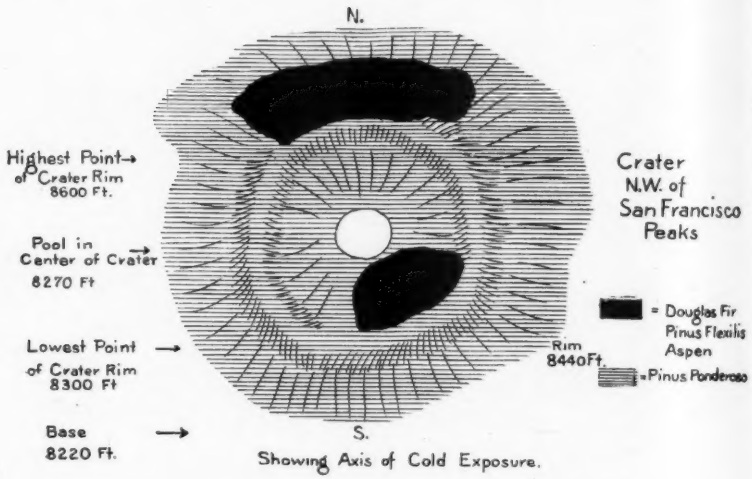



ing, as seen from above on the Peaks, like a race-track. Its base stands at 8,220 ft. and a short rise of 100 feet in height brings one to the rim of its bowl, which, at the bottom, holds an ill-appearing marsh. It is clothed without and within by trees, but the interesting peculiarity about it is their zonal distribution. One had said the sun from the southeast had cast a shadow of firs into the crater and down the opposite outer slopes, so regularly placed are the Douglas Spruce and the Rocky Mountain pine amid the encompassing *Pinus Ponderosa*. The rim by an easy grade rises to 8,600 ft. N.N.W. and then falls to an outlet S.W. Here one may see, at a glance, the result of slope exposure and determine it almost to the nicety of a degree. The axis of greatest cold in its effect on tree-life lay

north-north-west. This accorded with the showing of Wing Mt. and Crater Hill. The side of coldest exposure was thus not opposite to the slope of greatest heat, the latter lying southwest.

## VI.

Several things these various trips brought out clearly as to the habitat of trees. They showed in the first place that thinness of air offered no obstacle to the trees' growth. Provided thermometric conditions of climate were right, barometric differences had no perceptible effect. Altitude took the place of latitude in the distribution




of the several genera and species; the trees behaving in range as height above the sea instead of distance from the equator marked out for them so many different worlds, each peopled by its own denizens not at home in any other. It did this in a manner the more recognizable, by substituting for the scale on which it was performed feet in place of miles. On the level it takes such a distance to alter climatic conditions that the inevitable fringe of divided domain, where two species overlap, masks the full strikingness of their real differentiation. But on a mountain islet of vegetation a thousand feet will do the business, and the various kinds of trees succeed one another with startling abruptness. On the San Francisco Peaks this is peculiarly evident, the species segregating into definite communities, banding the peaks in distinct zones. And on

the mountain mass itself this is not a question of moisture, since all parts of it receive about the same rainfall.

Slope exposure in its effect on habitat was another point equally well defined in consequence of the circularity of the island communities. The distribution of the several trees became in some sort a matter of the conic sections, in which by passing a plane through the crater cone at the proper angle one could predict the habitat of a given spruce or pine; not quite as simply, however, as Dr. Merriam supposed, there being in fact two axes, one of cold N.N.W. and one of warmth S.W. Dr. Merriam's work, however, can hardly be too highly praised. For it is one of the best scientific productions of recent years.

It becomes an interesting problem to discover to what this orientation of cold was due. Unlike animals that can hibernate in winter, it seems that with plants, not the maximum temperature, but rather the minimum, determines their habitat. And it is evident from the way in which, as a rule, they wrap up their buds that the keeping out of the cold is with them an important object. Winds, therefore, must play a part in their life functioning; in other words, they are not the cold-blooded things we are apt to imagine them. But as they are fixed to the spot, they must take what comes. This may be too much heat, but, more vitally, is too much cold. It is thus not simply the amount of sun they receive, but the character of the winds which determines whether they shall thrive or perish. Slope exposure, pure and simple, has thus to be compounded with the direction of the coldest winds. As these at the latitude of the Peaks are the northwest winds, the axis of cold is shifted in that direction. In a similar manner, the winds to the west of south are more genial than those to the east of it, so that the southwestern becomes the warm slope.

But a third factor enters into the problem of tree habitat, the one to which the present research was specifically directed—the mass of land at a given height. Upon this point the evidence got by the investigation was no less conclusive. It is evident in the figures given for the heights at which different species were found upon the Peaks and elsewhere, but it becomes more easily evident to the eye when the profile of the Peaks is given in elevation banded by the several tree zones, as is done in the accompanying charts. The plateau effect then becomes visible at a glance.

On looking at the diagrammatic picture of the San Francisco Peaks, chart No. 1, one sees first the fundamental zonal distribution; secondly, the effect of slope exposure; in the Fir zone that tips the

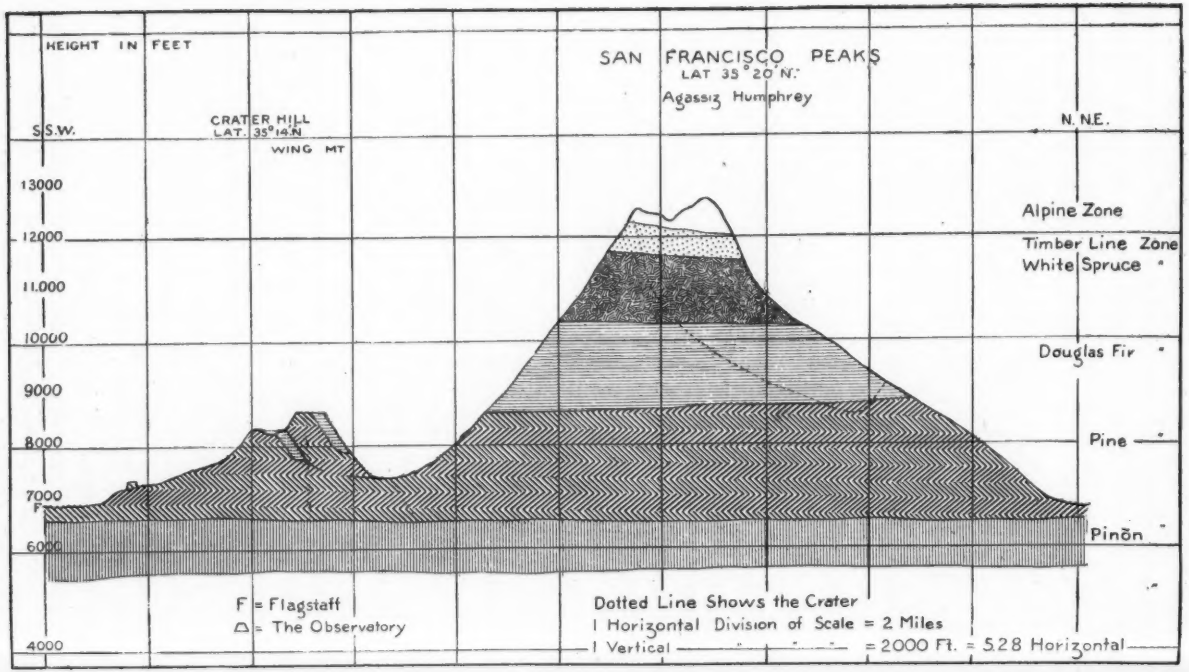
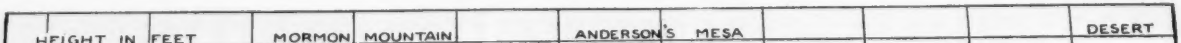

HEIGHT IN FEET
SAN FRANCISCO PEAKS
LAT 35° 20' N.
Agassiz Humphrey
S.S.W.
CRATER HILL
LAT. 35° 14 N
WING MT
N. N.E.
13000
12000
11.000
10000
9000
8000
7000
6000
4000
Alpine Zone
Timber Line Zone
White Spruce
Douglas Fir
Pine
Pinon
F = Flagstaff
Δ = The Observatory
Dotted Line Shows the Crater
1 Horizontal Division of Scale = 2 Miles
1 Vertical = 2000 Ft. = 5.28 Horizontal

CHART No. 1.


HEIGHT IN FEET
MORMON MOUNTAIN
ANDERSON'S MESA
DESERT

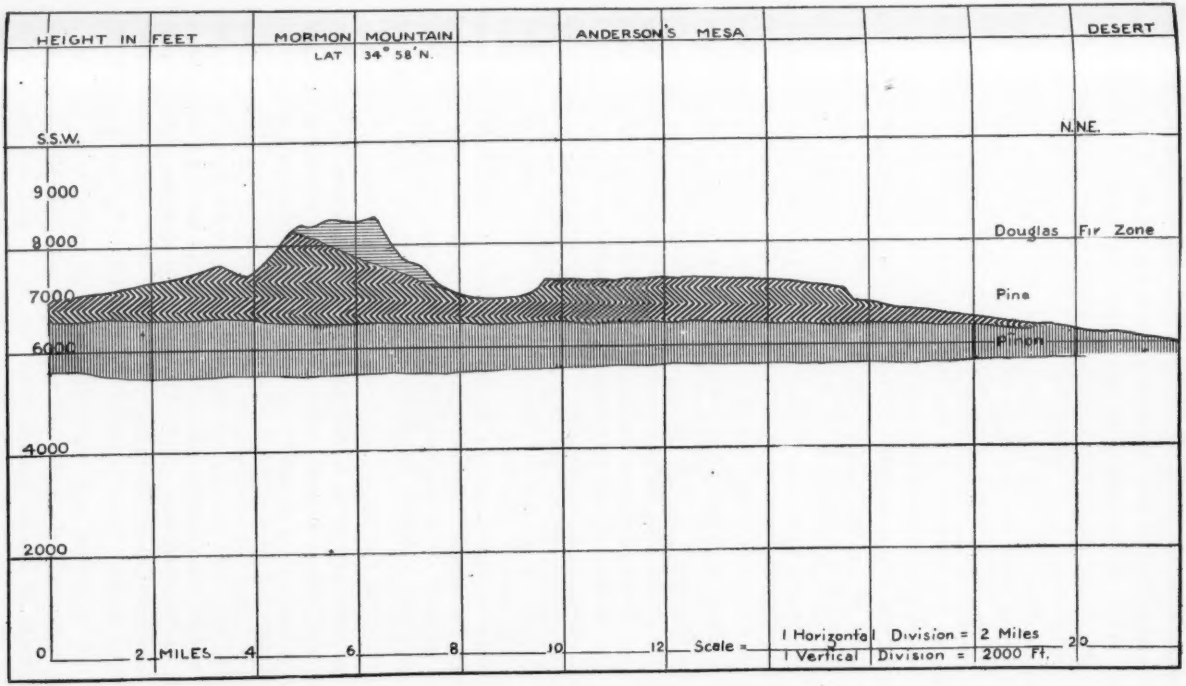

HEIGHT IN FEET
MORMON MOUNTAIN
LAT 34° 58' N.
ANDERSON'S MESA
DESERT
S.S.W.
N.N.E.
9000
8000
7000
6000
4000
2000
Douglas Fir Zone
Pine
0
2 MILES
4
6
8
10
12
Scale = 1 Horizontal Division = 2 Miles
1 Vertical Division = 2000 Ft.
20

CHART No. 2.

northern flanks of Crater Hill and Mormon Mt. and in the north-downward tilt of the upper zones, the Alpine, the Timber-line and the White Spruce zones of the Peaks. But with attention one is struck by something else, something which indeed is evident even in Merriam's diagrams, though not pointed out, but much more so here. The zones tilt less the greater the land-mass under them. Thus, not only do the lower zones, which rest on more land than those higher up, tip down less to the north, but the lowest actually rise on the north against the effect of slope exposure, the plateau generation of warmth more than counterbalancing the opposite influence due the aspect. A more striking demonstration of the potency of a plateau could hardly have been devised.

The like action may be followed in its smaller ramifications. Thus the fir zone falls much lower on Crater Hill and Wing Mt. than where it bands the Peaks. The same effect is visible in the alignment of the zones on Mormon Mt., chart No. 2, as compared with those upon the greater mountain mass of the Peaks. The fir zone was lower on Mormon Mt., both north and south, than it was on the Peaks; and one may notice as between it and Crater Hill the effect of the presence or absence of the mass of the Peaks themselves. The influence of a raising of the whole height of land is thus brought out, not in one, but in every instance where it was tested and not less interesting than the character of the country is the prettiness of the proof.

Nor is the reason for it unrecognizable; though it might not have been argued *a priori*. It consists evidently in the heating of the ground. It is at once clear that a small body of land warmed to a certain temperature must cool off quicker than a large one. Especially is this the case if the small one be in the form of a pinnacle, since it exposes itself to cooling on the sides as well as on top. A plateau, therefore, should, other things being the same, have a higher temperature than a peak. This should be reflected in the behaviour of its tree life. What is, perhaps, surprising is the greater effect relatively of the sun on the ground as compared with the air than what one would have supposed. But Very's latest investigation on the day temperature of the Moon—which reaches 370° F.—quite falls in line with it.

The subject of a plateau's climatic effect on temperature and thence on animal and vegetable life as compared with a peak's is one not confined to the earth; for in its general bearing it is planetary.

# GEOGRAPHICAL RECORD.

## NORTH AMERICA.

EXPEDITION OF DR. LUMHOLTZ TO MEXICO.—Dr. Carl Lumholtz started late in May for Sonora, Mexico, in the arid region of which he is going to make researches of an ethnological and physico-geographical character. He will return some time next winter. His principal field is the desert region between Rio de Altar and the mouth of the Colorado River as well as the upper part of Lower California. There is, in a general way, no surface water here; but water is supposed to exist at a depth of 30-50 feet below the surface. The vegetation is that peculiar to the arid region of the South West, cacti, etc.

Dr. Lumholtz will, in the beginning, be accompanied by half a dozen or more Mexicans, and will equip his expedition in Mexico, where the mules are hardier than in the United States. Water will often have to be carried along on mule back. The Indians among whom he will live for many months are the Pima, Papago and Cocopa.

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THE FOREST SERVICE.—In the *Report* of the Forester for 1908, (U. S. Dep't. of Agriculture, 1908,) Mr. Gifford Pinchot says that the estimates of the present stand of merchantable timber in the National Forests (Forest Reserves) obtained during the year, put the total at about 390,000,000,000 board feet. This estimate is rough, but rests upon better data than have hitherto been obtained. As the total lumber cut of the country for 1907 was slightly over 40,000,000,000 board feet, the area of our forests, controlled by the national government, would supply lumber for the entire United States for only about ten years, or wood material of all kinds for perhaps five or six years. The National forests embrace about one-fourth the wooded area of the country, but are now supplying less than 1 per cent. of the wood consumed. The most important work in 1909 will be the establishment of a number of National Forest experiment stations where the most important silvicultural problems will be investigated through a long series of years.

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BRANCH OFFICE OF THE U. S. GEOLOGICAL SURVEY AT DENVER.—The Survey has opened a branch office at Denver to facilitate its western work. The office will be a base of supplies for the engineers who are kept in the field many months each year making geologic studies of mineral deposits, conducting topographic surveys for the base maps of the geologic atlas, mapping the national forests, investigating surface and underground waters, and collecting statistics of mineral production. A supply of copies of the publications of the Survey, available for free distribution, will be kept on hand, as well as a complete file of the topographic maps, geologic folios, and other publications, subject to sale. The office was opened on April 1st, in the Commonwealth Building, and Mr. R. C. Miles is at present in charge.

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DIFFERENCE IN EROSION OF AMERICAN DRIFT SHEETS.—In a recent paper (*Amer. Journ. Sci.*, 1909, p. 350) Mr. Frank Leverett discusses the measure of weathering and erosion in the Pleistocene deposits of the Central United States.

He shows clearly that the drift sheets of the different ice advances have been subjected to very different amounts of weathering and erosion, and that this difference can even be detected on the topographic maps issued by the United States Geological Survey. In illustration of this point reproductions, in black and white, of several of the topographic sheets are printed, and these vividly support his main thesis. The two sheets selected for the Wisconsin drift area, for example, show a minimum of erosion, with extensive flat-topped areas with almost no dissection; while the sheets from the area of the much older Kansan drift are greatly dissected, with only narrow flat-topped divides as yet unconsumed. The difference in erosion on the two sheets of drift is most striking and furnishes convincing topographic evidence of the long period of time that separates the two periods of ice invasion. The topographic sheets reproduced in the article, and others from the same regions, will serve as excellent material for class room work in physical geography. Mr. Leverett also discusses other phases of the problem of the different ice sheets and presents a correlation of American drift sheets with those of Europe. R. S. T.

## SOUTH AMERICA.

Man and Climatic Change in South America.—In the *Geographical Journal* (March, 1909,) Mr. Isaiah Bowman, Assistant Professor of Geography at Yale University, discusses the evidence for climatic change in South America within the human period. Three sets of evidence are analysed, the observations of Darwin in central Chile, of Moreno in Argentina, and of the Yale South American expedition of 1907 between Chile and Bolivia. It is found that in each group there are evidences of a convincing sort, and these are found to be precisely those physical facts and objects that each investigator observed directly. Darwin and Moreno observed ruins where now no water can be found or could possibly be carried by irrigation ditches, and it is pointed out how slight a change is required on the margin of habitability to enable man barely to live or to drive him out. It is established by Moreno that agriculture was once carried on in northwestern Argentina on a scale demonstrably larger than would be possible to-day. The results of the Yale South American expedition of 1907 relate to the abandoned trails and corrals of the Lake Huasco basin in the Sillilica range (lat. 21° S.), on the boundary between Bolivia and Chile. It is shown that old roads and corrals now occur over 100 feet above the floor of the basin. They are in absurd situations for existing conditions, without water or shelter, and must have been used at a time when the localities occupied by the existing roads and corrals, with their adequate water and pasturage, were covered by the ancestor of Lake Huasco, a lake of vastly greater extent than the existing one. The well-developed shore lines, terraces, etc., of the old lake are direct evidences of climatic change and the correspondence of position of these and the old roads, and the better position of the new roads, are offered as inevitable evidences of climatic change during the period in which man occupied the region and conducted trade by caravan. The article is illustrated by two photographs and two new maps of the Huasco basin and the old and new roads, springs, and corrals.

## ASIA.

Exploring the North Eastern Coast of Siberia.—The Imperial Russian Academy of Sciences has fitted out a large expedition for the scientific exploration

of the northern coast of Siberia from the Lena River to Bering Strait. The party started from St. Petersburg in the middle of March. It is divided into two sections. The first, under the leadership of the geologist, U. A. Volossovitch, will cross the coastal regions from the Lena delta to Nishne Kolymsk. The second, in charge of J. P. Tolmatchev, will carry on the work from the mouth of the Kolyma to Bering Strait. The latter hopes, by the end of September, to reach East Cape and to go on a whaler to Kamtchatka and Vladivostok.

The Russian Hydrographic Office, on March 28th, started a survey party for Irkutsk for the purpose of descending the Kolyma River to its mouth. It is in charge of Captain Ssedov, and the purpose of the investigation is to determine how far inland the Kolyma is available for navigation by large trading vessels. It thus appears that, some thirty years after Nordenskjöld made the North-East Passage, in 1878-79, the Russian Government has set about the work of investigating the possibilities of opening up Northeastern Siberia. (*Pet. Mitt.*, No. 4, 1909.)

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LITTLE-KNOWN PARTS OF ARABIA.—In his first article on "Problems in Exploration" (*Geog. Journ.*, Dec., 1908), Mr. D. G. Hogarth said that away from the coasts of the huge peninsula of Arabia no part of it is well enough known to geographers to be described as fully as we may describe Tibet. Almost the entire southern half of Arabia is occupied, according to native report, by a vast wilderness called generally *Ruba el-Khali, i. e.*, "Dwelling of the Void"; but while on its western edge are the dunes of *el-Ahkaf* and on its eastern edge is a rolling gravelly steppe which the Arabs call *el-Dahna*, no European has ever entered this immense tract, which embraces some 600,000 square miles.

It is a part of this region which Mr. G. W. Bury is now attempting to traverse. He has had much experience of travel in southwest Arabia, and he hopes now to undertake a far more extensive expedition than any he has yet carried out. His party, to whose expenses the Royal Geographical Society has contributed, will enter Arabia east of Aden and proceed *via* the Yeshbum valley and Nisab to Behan el Jezab and thence to Harib and Mareb, examining on the way some of the ruined or buried cities (such as Shabwa, north of Nisab) and possibly waiting in one or another of the places mentioned for a favourable season for further advance. From Mareb, where he will try to obtain copies of the inscriptions to be found there, Mr. Bury hopes to move northward along, or in touch with the caravan route to Riadh, if such a route still exists and water is procurable, making occasional journeys eastward into the desert. If it should be possible to reach Aflaj *via* Wadi Dawasir, he will try to traverse the Yabrin district, keeping on northwards towards Hautha—a route which should enable him to strike the supposed Oman-Mecca pilgrim route, if it has any real existence. If successful in this and the route seems practicable, he will make for Muskat. Otherwise he will choose one of various courses which will lead him either north to the Persian Gulf, west (from Riadh) to the Red Sea or south to the Hadramaut.

Meanwhile, Professor Alois Musil is engaged in explorations in northern Arabia. After preparing himself for his new expedition by studies in astronomy, meteorology, and physical science, he set out last year for the little-known portions of the north Arabian desert lying inland from Koweit between Babylonia, the Persian Gulf and the Hejaz railway. His intention is to carry out a topographical survey and make a map of this tract, which is very rich in early

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historical association; at the same time, he will make a thorough study of its archæological and ethnographical features, including its inscriptions. The cost of this exploration, which is expected to occupy about eighteen months, is borne by the Austrian Government, the Vienna Geographical Society, and other bodies and private individuals.

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## POLAR.

DR. CHARCOT'S JOURNEY SOUTH.—A copy of a letter written by Dr. J. B. Charcot, leader of the French South Polar Expedition, to the Academy of Sciences, Paris, has been sent to the American Geographical Society at the request of that explorer. He wrote from Deception Island on Dec. 24th, 1908. His steamer, the *Pourquoi-pas,* on Dec. 22d, reached this island, which is in the group of the South Shetland Islands, off the west coast of West Antarctica. Approaching the island, the expedition met the Norwegian whaler *Ravn* and found three whaling companies established on the shore, one Chilean and two Norwegian. Dr. Charcot was here able to replenish the coal he had consumed (about 30 tons), since leaving South America.

The scientific work of the party was here vigorously prosecuted. The naturalists, Messrs. Gain and Liouville, and the geologist, Mr. Gourdon, collected specimens, Mr. Bongrain observed the second contact of the eclipse of the sun on Dec. 23d and continued a series of pendulum observations begun at La Plata and Punta Arenas, Mr. Rouch made soundings and dredgings and conducted meteorological observations, Mr. Godfroy drew a plan of the bay in which their vessel was anchored, and Mr. Senouque made here, as well as at Punta Arenas, magnetic and actinometric observations during the eclipse. A survey of the bay was also carried out.

Deception Island, Dr. Charcot says, is a volcanic island, circular in form, whose crater, partly submerged, provides a large and fine harbour, very deep, the entrance to which is through a narrow opening between two cliffs, hardly visible from the offing. The American sealing captain, Pendleton, was probably the first to enter this harbour, which became frequented by whaling and sealing vessels and was then wholly abandoned for more than a century. The Englishman Foster, on the *Chanteclerc,* sojourned at Pendleton Cove from Jan. 9th to March 4th, 1829, while making numerous pendulum observations. At the same spot, Mr. Bongrain now made his series of pendulum observations and regulated his chronometers.

Deception Island has again become an important centre for whaling operations. The fleet, now at work, has its headquarters in this bay, which is very favourably situated, with plenty of fresh water; warm water, with a temperature of 70°, is also found. The fleet consists of two steamers of from 3,000 to 4,000 tons, three sailing vessels for carrying coal and other service, and eight small steam whalers supplied with harpoon-guns. These vessels frequently return to the harbour, towing in the killed whales. Two hundred Norwegians are engaged in this productive industry.

Dr. Charcot wrote that his expedition would leave Deception Island on the evening of Dec. 25th, for Port Lockroy and, after a brief visit to Port Charcot, he intended to proceed south, establishing as many stations as possible along the west coast of West Antarctica. The whalers say that in the three years they have been in the waters between South America and West Antarctica, they have

never seen so little ice as in the past season, a fact that the explorer is inclined to interpret as of good omen for his work. If the lack of ice in Antarctic waters is due to the non-detachment of ice from the shores, it may make the advance of the *Pourquoi-pas* more difficult; but the fact that the land ice was found this year adrift much further north than usual encourages the hope that his endeavour to reach a comparatively high latitude on his ship may meet with fair success. His party was well, full of hope for the future of the expedition and much encouraged by the practical results already attained. Dr. Charcot thinks it is time that French whalers should enter the field, which whaling affords opportunities for profitable enterprise. Earlier references to the expedition will be found in the *Bulletin* for 1908, pp. 103, 554 and 752, and in the March number, 1909, p. 161.

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Professor Nordenskjöld going to Greenland.—Professor Otto Nordenskjöld of Gothenburg, Sweden, will visit, this summer, the west coast of Greenland for geographical and geological purposes. He intends to study the ice-free coastal region of the Holstenborg district and will try to determine the southern limit of the inland ice cap. Zoological studies will be carried on by Mr. H. Skoog.

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The Search for the Collections of the late Mylius Erichsen.—The March *Bulletin* (p. 160) had a notice of the small expedition that was to leave Denmark, this summer, to search for the diaries and collections which, it was thought, the lost explorers must have left in some câche when they were no longer able to carry them. It now appears that this party is to be headed by Captain E. Mikkelsen, whose account of his sledge journey over the ice of Beaufort Sea was published in the *Bulletin* (Vol. 39, pp. 607-20, 1907). The party will leave Copenhagen in July, endeavour to reach more northerly winter quarters than those occupied by the Erichsen expedition near Cape Bismarck, and, next spring, will make a sledge journey north to the Mallemukfjeld, where the body of the Eskimo Brönlund was found, and thence to Denmark Fiord, whose coasts will be searched for any objects that the lost explorers may have left there.

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## CLIMATOLOGY.

Earthquake Weather.—In *Nature* (Jan. 28, 1909), Mr. R. D. Oldham notes the peculiar weather which accompanied the recent Italian earthquakes. A sudden fog settled down on the Strait of Messina. The Mexican earthquake of Jan. 24, 1898, was also followed by a heavy mist at a time of year when such phenomena are usually unknown. Rainfall is so often reported as the immediate successor of an earthquake that, Mr. Oldham says, "we can no longer reject the hypothesis of a real connection between the two." Mr Maxwell Hall has tried to explain the phenomena of earthquake weather by changes of the barometer gradient due to rapid upheaval of the ground. Professor Milne has suggested that the disturbance of the ground, when transmitted to the overlying air, may determine precipitation and may explain the apparent association of severe earthquakes with rain and mist. If the influence is mechanical, it must result from the vibratory motion of the ground, or else from the permanent changes of level, accompanied by the sudden upheaval or depression of the column of air above. Of this change of level there is still no satisfactory evidence. R. DeC. W.

THE COLD PERIOD OF MAY IN ARCTIC AND ANTARCTIC REGIONS.—To *Symons's Meteorological Magazine* (Feb., 1909), R. C. Mossman, formerly of the Ben Nevis Observatory, later meteorologist of the Scotia expedition, and now attached to the Argentine Meteorological Service, contributes an interesting discussion along the line of what has lately been well termed "world meteorology." Referring to the "cold period" which recurs, with some regularity, on the 11th, 12th and 13th of May, and is known on the continent as the Ice Saint's Festival, Mr. Mossman finds that this period was well marked at the winter quarters of the *Discovery* in 1902-03, as well as at Cape Adare in 1899. It also comes out clearly at a large number of places in the Argentine Republic north of latitude 40° S., as well as at the South Orkneys, in latitude 61° S., but does not appear in the vicinity of Cape Horn nor on the Atlantic or Pacific coasts of South America up to about latitude 40°. This latter fact is due to the development of a cyclonic area over that region, whereas over the northern part of Argentina and Chile well-marked anticyclonic conditions prevail. The cold period of May is found to be a bi-polar phenomenon, experienced from latitude 78° S. to at least latitude 84° N. (*Fram*), over the region under discussion. It is especially marked in Chile and Argentina in the south, and over the greater part of Europe in the north. It is absent, or but feebly developed, in South America south of latitude 40° S. Where it occurs, it is associated with high pressure, and the anticyclonic conditions relative to the normal are most pronounced in Antarctica. At places where it does not occur, cyclonic conditions prevail.

Mr. Mossman affirms that warm and cold periods are synchronous in both hemispheres. This he says, is especially the case over the Atlantic area and the adjacent continents from about long. 70° west to 30° east. If the mean daily temperatures at the winter quarters of the *Discovery* in lat. 78° S., and of the *Scotia,* in lat. 61° S. are plotted for 1903, and compared with similar curves for Europe, the interrelation can be seen at a glance. That there are such intimate interrelations between that part of the globe covered by the North and South Atlantic seems to be due to the regular sequence of the atmospheric "centres of action," which are the north polar anticyclone, the Iceland low, the North Atlantic high, the South Atlantic high, the Weddell Sea low and the Antarctic high, the centres of all of which are, meteorologically, approximately in the same meridian. R. DEC. W.

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AN INTERESTING BAROMETER.—Otto von Guericke (1602-1686), well known for his connection with the famous "Magdeburg hemispheres," constructed a water barometer about the year 1660. By means of this, he was able to foretell the coming of a severe storm, which occurred in September, 1660. The column of water, as is commonly known, held up by the ordinary atmospheric pressure at sea-level, is about 34 feet in height. Von Guericke's water barometer was doubtless the longest one ever constructed until very recently. We learn, however, that Father Alfani, at Faenza, the birthplace of Torricelli, has now made the largest barometer on record. The tube is filled with purified oil, freed from air, and the column is 36.7 feet in length. R. DEC. W.

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## EDUCATION.

GEOGRAPHY IN THE UNIVERSITIES.—The May number of the *Educational Review* has an article by Mr. Avard Longley Bishop, of Yale, on "Geography in the Universities Abroad," in which he gives facts to show that geography in our

Universities, to-day, has, on the whole, made less advancement than had been made in many of the European countries nearly a quarter of a century ago. His comparisons would have been still further emphasized if he had given some idea of the great progress in the study of geography in the European Universities themselves since Dr. Keltie, in 1885, reported the facts that Mr. Bishop largely quotes. He shows, however, that, in recent years, the subject has been gaining ground rapidly among the higher institutions of learning in the United Kingdom, as is evident from the reports occasionally published in the *Geographical Journal* and the *Scottish Geographical Magazine;* and we have only to turn to the semi-annual lists of the geographical work planned for each half year in the Universities and higher schools of Germany, Austria and German-Switzerland (in *Petermanns Mitteilungen*) to be convinced of the variety of general and sub-topics and the thoroughness of treatment of the whole subject in the higher institutions of learning in Central Europe.

The chief significance of Mr. Bishop's article is that it calls attention to a most encouraging tendency now observed in a number of our own higher schools. He says:

"That geography, as such, as well as in its applied forms, is coming to be recognized in this country as a valuable discipline for the college student is no longer seriously questioned. The extent to which numerous courses of this order are working their way into the curriculums of a considerable number of colleges and universities is convincing on this point. Their highly cultural and practical value is becoming apparent to the educational leaders of the country, and plans are in progress, it is said, for establishing departments of geography in some of the leading universities. * * * It is not the desire of the present writer to underestimate the excellent work that is being done in geography at certain colleges and universities in the United States to-day. But, those who are acquainted with the situation are forced to admit that we are behind most of the European countries in handling this subject. There is scarcely a single professorship of geography alone in any of the larger universities in the United States at the present time, although, as has been shown, they were common in Europe nearly a quarter of a century ago. Yet signs of progress are evident. A considerable number of professors, assistant-professors and instructors are giving the whole or part of their time to developing the subject, and in some of the colleges or training schools professors of geography are to be found. Furthermore, it is becoming increasingly clear, that those who are devoting their efforts towards extending geographical instruction in the higher institutions of learning do not merit the criticism which has been made so often in the past, that they are attempting to elevate to university grade a subject whose proper sphere is the high school. The experience of England and the countries of continental Europe is sufficient answer to such criticism."

Those who make this criticism are certainly not familiar with the content of geography as the subject is understood abroad. A recent university report in this country, alluding to efforts to expand geographical instruction in the institution, referred to nothing but regional geography. It will doubtless be of much value to those who are planning the bases of geographical courses in our higher schools if they will study the scope of the subject as it is presented in schools of the same grade in Europe; and also observe in the *Reports* of the International Geographical Congresses and of the Geographical Congresses of Germany, France and Italy, the wide range of the subject and of its economic, cartographic

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and other practical applications as these phases are scientifically treated by the leading geographers of Europe.

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## VARIOUS.

FIFTY YEARS A CARTOGRAPHER.—Mr. Hermann Habenicht has completed fifty years of cartographic service in the establishment of Justus Perthes, Gotha. Many of his map products, long ago, distinguished him as a cartographer and geographer of the first class. Some of his prominent works have had helpful influence upon the maps of other countries. His drawing of the Rocky Mountains on the six-sheet map of the United States in Stieler's Hand-Atlas was so good a generalization that his work has been used to a considerable extent in the delineation of the Rockies on school and wall maps. More than fifty sheets of Stieler's Hand-Atlas were drawn by his practiced hand and, in the last edition in 100 sheets, over a third of the maps are his work or were prepared or corrected under his supervision. Habenicht also had most to do with the production of the "Taschenatlas" and the "Seeatlas" of the Gotha house of which hundreds of thousands are in use in various parts of the world. His ten-sheet map of Africa, issued in 1885, was a remarkable compendium of our knowledge of the continent at that time, though in some respects open to criticism. In the appreciation of the cartographer which appears in *Petermanns Mitteilungen* (No. 4, 1909), it is said that he is still in full activity. Geographers, teachers and students will be glad if we may have many more of his works. His most important contribution to educational geography is his series of 16 physical school wall maps based on the plan of E. Sydow's maps, which had long been in use.

Professor Wm. M Davis has written an account of the physical geography of the United States for the new edition of the Encyclopædia Britannica; also a similar paper, but with greater attention to human conditions, on North America, exclusive of Mexico, for a work entitled "Die Kultur der Gegenwart." His hand-book for laboratory work in schools entitled "Practical Exercises in Physical Geography" (noticed in the *Bulletin* 1908, p. 573), was in preparation for a part of his time during four years.

Dr. W. E. Geil of Doylestown, Pa., has returned from China, where he followed the Great Wall throughout its entire length from the eastern coast of China to the borders of Tibet. He says that he has discovered western extensions of the wall, about 200 miles long. It will be recalled that Dr. Stein on returning from his recent explorations in Central Asia, said he had found two extensions of the wall, one running along the northern border of the Su-chou and Kanchou districts while the other meets this ancient wall at right angles and was built to close the route between China and Central Asia.

The Department of Geology of the University of Wisconsin has prepared a relief map of the Malaspina glacier and the adjacent region near Mount St. Elias and Yakutat Bay. It includes about 7,350 square miles in Alaska and Canada. Its vertical and horizontal scales are the same (1:80,000), and the model is about 7 by 4⅔ feet. It shows a part of the St. Elias Range, with its numerous glaciers, one great group of which united at the foot of the mountains in a piedmont glacier, the Malaspina, whose area exceeds 1,500 square miles. The east half of the model shows fiords with cirques, hanging valleys, etc., the glacial coastal plain, known as the Yukatat Foreland, marginal lakes, medial, terminal, and recessional moraines, and outwash plains. The Department of Geology is prepared to sell plaster-papier maché reproductions of the original clay model.

# GEOGRAPHICAL LITERATURE AND MAPS.

(INCLUDING ACCESSIONS TO THE LIBRARY.)

## BOOK NOTICES.

**La Basse Bretagne. Étude de géographie humaine. Par Camille Valaux.** 320 pp., 6 plates and 9 Figures. Ed. Cornelie & Cie, Paris, 1907.

The author is professor of geography at the government naval school. His fine monograph of Armorica, or Lower Brittany, a thesis for the doctorate of the University of Paris, is a study in the geography of man as influenced by the geologico-geographical conditions of that peninsula. The area under discussion comprises the department of Finisterre and the adjoining parts of the departments of Morbihan and Côte-du-Nord as far east as a line drawn from St. Brieuc on the north coast to Vannes on the Bay of Quibéron. The country west of this line forms a geographical unit by reason of its peninsular isolation and its geological composition, the most striking feature of which is the absence of formations younger than the palæozoic age and the fractured condition of the rocks owing to the heavy disturbances which the old mountain system of Armorica has undergone. The soil, with very few exceptions, is therefore the direct product of the decomposition of the old rocks, without the usual cover of diluvial or alluvial sediments; and these rocks themselves, being heavily disturbed and often standing on edge, their respective areas are so limited that the conditions of the soil vary to an extent which gives the geological map the aspect of a sample chart.

The geographical effect of this state of things has been the creation of many small natural units which have brought about, in the condition of man, a corresponding variety of economically and socially different groups. While elsewhere, contact with the surrounding country and the influence of commerce and traffic would long ago have obliterated such differences, the peninsular location of the country has, in this case, kept out the levelling influence of through traffic without which, even within the province, the real stimulus for contact with neighbouring regions has been lacking. The country thus retains to this day the aspect of a congregation of small geographical individuals, a condition which has favoured the preservation of the old traditions, customs, and language, but which is a great hindrance to the economic development of the land.

The fundamental divisions of the peninsula are embodied in the two old Breton names *Ar Mor* (hence the name of Armorica) or country of the sea, which embraces the coastal regions, and *Ar Coat*, or country of the woods, which denotes the interior. They are characterized, the former by its maritime interests, the latter, by agricultual ones. As the latter is three times as large as the former, the peninsula must be designated as a pre-eminently agricultural region. The attachment of the Breton to his native soil is, therefore, proverbial. As the traditional system of inheritance requires the land of the parents to be divided among all their children, nobody is without his lot, however small it may be.

Even the mariner of the *Ar Mor* owns his small farm which the wife takes care of in his absence and whither he returns to rest between his cruises. Industries are few and far between. The dismemberment of the soil allows only small quantities of workable minerals to be accessible in any one locality, so that whatever there was of lead, coal, and iron, was soon exhausted, and modern methods of mining on a large scale would not pay. Only the quarries, especially slate and granite quarries, continue to be paying investments in this rocky country. Pockets of kaolin have given rise to faience works, and the woods of the interior have encouraged furniture making, both on a small scale, and utilizing local water power; as these industries bear a distinctive local character their products have a fancy and artistic value, and they may therefore survive in spite of modern competition.

A few industries have also been artificially introduced, such as the arsenals and powder mills near Brest and Lorient, and tobacco manufacture in Morlaix; but their influence is so small as to be almost negligible. The agricultural areas reflect the variations of the soil and are each confined to narrow limits. The granites of the interior allow a moderate amount of farming; the shales in the central basin correspond to the grazing regions for horses and cattle; the sandstone ranges of the interior are a country of heaths good only for sheep raising. The *Ar Mor* of the north is, thanks to a deposit of quaternary clays, to the fertilizer which the sea furnishes in the shape of kelp and calcareous marls, to the vicinity of the English market and to the sunny slopes of its lesser peninsulas, a province of most intense market gardening which supplies England with fresh vegetables and berries, and the world with canned French peas; the southern *Ar Mor* is the country of the large orchards where the famous cider of Brittany is made.

The *Ar Coat* of the present is no longer a country of the woods. Only small bands of forest linger on the ranges of the Montagne d'Arrée and Montagne Noire, and a limited amount of woodland is found in the granite country of Vannetais and Cornouaille. They alternate with (which in many cases means that they have been supplanted by), heaths, swamps, and bogs, which cover one-fourth of the whole *Ar Coat*. Attempts at improving the country have met with little success, partly on account of the imperfect methods used in the process. The small value of the soil is graphically demonstrated by the size of the fences or enclosures which are double walls of earth or stone, from 1 m. to 2.50 high and 50-80 cm. wide, planted with rows of trees which atone, to a certain degree, for the deforestation of the landscape. It is interesting that, in proportion as the value of the soil increases, these enclosures become narrower and narrower until on some of the islands they disappear entirely. On the whole, the sandstone and granite country of the interior acts geographically as a "pole of repulsion," where the inhabitants leave their native soil to find better opportunities in the cities, or lead nomadic lives as charcoal burners, peddlers, and tramps.

The *Ar Mor*, on the other hand, combines, with the opportunities of a better soil, those of the sea. Here, therefore, the density of the population reaches figures unheard of in any other part of France, up to 177 and even 200 inhabitants to the square kilometer. The importance of the maritime pursuits of Brittany has often been over-estimated, not only because they extend only over a very narrow rim of the coast (about 10 km. inland) while the bulk of the country depends on its soil, but also because even within this zone the most intense agricultural life of the country is concentrated in the gardening and fruit raising regions of the

north and south coasts. Especially since steam navigation has reduced the number of hands needed on the ships, the maritime interests of Brittany have considerably declined. Now the Briton of the *Ar Coat* enters the navy of his country, serves his term, and retires to his farm to live on his pension upon completion of his service. Very much the same is the life of the fisherman. Coastal fisheries dominate by far over deep sea fishing, the vessels going to Iceland hailing from two, and those going to the Banks from three ports only.

By far the most important fishing industry are the sardine fisheries, which have almost revolutionized the social and economic conditions of the regions which they influence. The cause lies in the fact that the sardine fisherman cannot, like the one who goes for other fishes, land his catch at his native port and take it to the nearest market. The sardine is so perishable that it must be put up almost immediately after having been caught, therefore its catchers must live as near the factory as possible, so that the sardine ports have become the only places in Brittany with a landless population, the only places on the *Ar Mor* where the type of the farmer-mariner is missing. Moreover, even if there were room enough for everybody to have his lot, there would be nobody to take care of it because, sardine canning being pre-eminently a feminine industry, every wife or daughter is working at the factory. The result is, that here alone has developed a modern proletariate which even the destitute conditions of the poorest parts of the *Ar Coat* have not been able to produce.

Aside from these agglomerations of the sardine centers Brittany is poor in cities of any considerable size. The stimulus of through traffic wanting, the towns are either small local centers on country cross roads whose importance is mostly based on market privileges, or small fishing ports at the heads of estuaries, none of them having over 20,000 inhabitants. The lack of contact with each other and with the outside world has worked as a heavy drawback with regard to almost every problem of public life. Hence Brittany is to this day the country of "survivals," economically, socially, linguistically. Even its great natural blessing, the prolificness of its population whose birthrate surpasses that of every other part of France, acts as a hindrance to its progress because it supplies an abundance of cheap labour which stands in the way of the introduction of modern methods and machinery which would develop its natural resources. For with all its overpopulation, the author is confident that the peninsula can be made to support every one of her sons and daughters, and even a larger population than at present if only it could be more scientifically exploited. A well-devised system of railroads which would open up the country and connect it with the modern world is the greatest need for its near future.

The text is supplemented by a series of maps and diagrams which add greatly to the usefulness of the book which, as a whole, must be ranked with the best productions of the last years in the large and important field of "Länderkunde."

M. K. G.

**The Physics of Earthquake Phenomena. By Cargill Gilston Knott.** xii and 283 pp., Illustrations, and Index. The Clarendon Press, Oxford, 1908. Price, $4.75.

This work embodies the Thompson lectures given at the United Free Church in Aberdeen in the year 1905-1906. The author was for several years professor of physics in the University of Tokyo, where he was associated with Milne and closely followed the development of seismology in Japan. The introduction re-

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views the conditions of the earth's crust which lead to strain, flow, folding and faulting, these being fundamental to earthquake agitation. The author then outlines the sensible phenomena of shocks. Among these are sounds, caused by the refraction into the air of perhaps less than one thousandth part of the wave energy that affects the rocks. Alluvial soils kill sound vibrations while harder strata are likely to communicate them. Wave motions of the ground are undoubted, but their height is likely to be exaggerated, since no fixed vertical line serves as a standard of comparison. Whirling motions and the twisting of monuments or the shearing of neighbouring areas without faulting are the natural result of interfering trains of waves, producing a vortex.

Professor Knott holds to the conception of the epicenter, or epifocal tract, which is readily determined in inhabited regions. He recognizes, however, that exact localization is difficult because there may be two or more centers and the disturbance may be extended in a linear manner. Thus eisoseisms are not often circular. Sub-oceanic origins are naturally difficult to localize. These considerations are given in a chapter on seismic surveys which also records efforts to determine intensities by dynamic means rather than by an imperfect scale based on human sensations and observations of injured structures. Under instrumental seismology is described the development of seismometers, following the simple seismoscopes which only record the occurrence without noting or recording the successive intensities. It is believed that the modern seismograph responds with "fair accuracy" to the motion of the ground.

While most of the destructive shocks occur in regions of earthquake frequency, there are exceptions, as at Comrie in Scotland and the Lisbon catastrophe of 1755. De Ballore is quoted as discarding the effort to show distribution over the world by continuous seismic lines, that investigator having adopted a discontinuous plan of marking seismicity of localities by black disks of differing radii. Accurate mapping of distribution is of course hindered by the existence of non-inhabited regions and by the great extent of the ocean surfaces of the Globe. Observations on ships cannot afford as secure data as those made on land and some parts of the ocean are visited by but few ships.

Considerable space is given to the discussion of periodicities. Two factors determine the frequency of shocks, viz.: "seismic sensitiveness," a condition belonging within the earth's crust; and stresses derived from some source, such as planetary bodies or atmospheric pressures. The author recognizes a winter maximum of shocks and thinks it is connected with the summer and winter shifting of areas of high pressure between the continents and the oceans. The gradient along the shorelines is steeper in winter than in summer and this condition coöperates with the instability of the crust in such regions. Influence is also conceded to the falling and melting of snows, while the periodicity of rain and of snow-melting may also affect shoreline deposits and thus influence the isostasy of land masses.

It is now well known that instruments record a great number of vibrations which are not felt by man and are not "shocks" in the ordinary sense. It was Milne who, as long ago as 1883, thought it not unlikely that instruments might yet detect a large earthquake at any point on the lands of the globe. Six years later, at Potsdam, a disturbance was recognized as centering in Japan. Several sample records are reproduced in the text and an exposition of their meaning is given. Elasticity, elastic waves, and seismic radiations, each have chapters, with physical discussions of a technical character.

Under "miscellaneous relations" we find references to destruction of buildings

and the snapping of submarine cables. Milne has shown that on an average there is every year one dislocation for every 434 miles of cable, a result which seems to follow naturally from the sub-oceanic origin of a majority of shocks. The connection between volcanoes and earthquakes is regarded as minor and local. The author does not favour the theory of Dr. See with reference to the percolation of sea water and the action of steam as a common cause of volcanoes and earthquakes. The volume closes with a brief notice of theories of the earth's interior in relation to seismic activities. It is held that the interior may be plastic under the action of long-continued forces and yet highly elastic to rapid vibratory motions. A. P. B.

**Lands Beyond the Channel. An Elementary Study in Geography. By H. J. Mackinder.** xii and 276 pp., Illustrations, Maps and Index of Place Names. George Philip & Son, Ltd., London, 1908. Price, 1s. 9d.

This book, a companion volume to Mackinder's "Our Own Islands," is a real geographical reader adapted to the interests and needs of children of the intermediate and upper grammar grades. Devoted to the salient geographical features of the continent of Europe and of the lands bordering the Mediterranean, it is not a mere series of scrappy descriptions of glimpses of physical features. Although written in part as if the readers were taking railway journeys, the volume is not a guide book or a railway folder in tone or scope. The book is written by a master who sees human, geographic relations in the landscapes he pictures and whose eyes have evidently always been open to the features of real geographic significance. Enough history is included to make clear the larger problems of the distribution of races, languages and religions in Europe to-day—a necessary foundation for understanding existing political conditions.

The volume is as interesting for an adult as for a child, for it is clearly written, well printed and illustrated by many maps and illustrations. It is not and does not pretend to be a textbook or reference volume. It is merely a "supplementary reader," but it is the most satisfactory book of its kind we know.

R. E. D.

**Early New England Towns. A Comparative Study of their Development. By Anne Bush MacLear.** 181 pp., and Maps. Columbia University. Longmans, Green & Co., Agents, New York, 1908. Price, $1.50.

Salem, Dorchester, Watertown, Roxbury and Cambridge are the chief subjects of this study. The origin and general government of these and other communities are set forth and there follow several chapters of a special character on town courts, finances and lands, on town government in detail, and on churches and schools. The author states that the characteristic features of the New England town of the seventeenth century resulted, in part at least, from the topography of the country, and that the colonists were forced, not only for protection but by the geographical features of the land, to dwell in groups. It would have added to the interest of the monograph if these statements had been interpreted and the influential geographic conditions set forth. A volume apparently prepared with conscientious study of the historical data, but so devoid as this of the atmosphere of geography, illustrates the importance to the historian of training in geographic principles. With such training, environment assumes its due importance and the human annals rest on a suitable foundation. Perhaps the nearest approach to geographic material is found in the chapter on town lands, and in the sketch maps which show the allotment of home lots, planting fields and commons for Cambridge and Watertown. A. P. B.

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**Leçons de Géographie Physique. Par A. de Lapparent.** Paris, Masson & Co. 3d edition, 1907.

The principal merits of Lapparent's great textbook, the lucid presentation of systematical physical geography, and the geomorphogenic description of the continents and countries, are the same in this edition as in the two previous ones. The book has been revised and enlarged along various lines, principally in the chapters on glacial phenomena. The geological descriptions of the Alps and Pyrenees have been entirely re-written in accordance with the results of modern researches. The number of illustrations, too, has been enlarged, most of the new additions being photographs illustrating typical forms of relief. A most valuable innovation is the addition of an alphabetical index which will greatly increase the usefulness of the book. In all other respects the work has preserved the qualities that have made it one of the standard works in its line from the day of its first publication, one of the books which, in the phrase of the book agent, geographers of any nationality "cannot afford to be without." M. K. G.

**Desert Botanical Laboratory of the Carnegie Institution. By F. Coville and D. T. MacDougal.** vi and 58 pp. Carnegie Institution, Washington, D. C. 1903. Price, 50c.

This laboratory was established at the suggestion of Mr. F. V. Coville, of the United States Department of Agriculture, who made an expedition to Death Valley in 1891 and saw the importance of the botanical problems offered by such regions. A journey was undertaken in the winter of 1903 for the purpose of finding a favourable location. Tucson, Arizona, was finally selected, for its distinctiyely desert climate and flora, the latter being of a varied character. Accessibility and habitability were also important conditions. These advantages are set forth somewhat fully and a historical account of Tucson is added. There are about 30 full-page plates, and in conclusion is a bibliography comprising eleven pages of titles in four groups—general treatises and those relating to climate, soil and water. Descriptive notes of several regions are given, but these are republished in a later and more complete volume, "Botanical Features of North American Deserts," which is noticed below. A. P. B.

**Botanical Features of North American Deserts. By Daniel Trembly MacDougal.** 111 pp., Maps and Illustrations. Carnegie Institution, Washington, 1908. Price, $1.75.

This study is the outcome of researches of the Desert Botanical Laboratory, by various authors, under the direction of an advisory board, and with Dr. W. A. Cannon as resident investigator. A first attempt to outline the features of American deserts was made in a previous publication, No. 6, which having been exhausted, some parts of it are included in this later and more complete discussion.

The work deals primarily with plant distribution and plant physiology, especially in relation to moisture, but this notice will seek to present features of general geographic interest. The Laboratory now has title to 860 acres of land for its experiments and observations. One of the most important areas for study is the delta of the Colorado, because of the arid climate and because the Salton and Pattie basins, with their occasional bodies of water, offer conditions similar to those which many regions of American desert have experienced during recent geological periods. Such regions have a highly specialized flora whose origin and distribution are sought to be ascertained.

Nearly half the volume is occupied with descriptive notes on various desert regions. There is an account of conditions seen in the transition from the well-watered districts of eastern Texas to the Chihuahua desert in the western part of that State, including Orange, Houston, San Antonio, Haywood and El Paso, the last point being 939 miles west of Orange and having but 10 inches of precipitation. The Otero basin is next described, which extends northward from El Paso and which offered one of the dangerous routes of travel in early days. It is now known, however, that water is to be found not far below the surface. The deposits of the basin, often saline, were made in the bottom of an ancient lake 2,000 square miles in area. A tract of 300 miles is now covered with the "white sands," which form dunes of comminuted gypsum, rising to heights of 60 feet. Columns of this material, protected by the branches, leaves, and roots of a species of sumac, are sometimes formed through the removal of the surrounding sands by the winds. It was found that the passage of a migrating dune over a surface left infiltrations which changed the soil and led to occupation by a different series of plants from that before present. In the desert hills west of Torres, one of the investigators saw a Papazo Indian bruise the interior tissues of a barrel cactus and extract two or three quarts of not unpalatable liquid which the native uses for drink and for mixing his meal.

A visit is chronicled (1906) to Tehuacan in southern Mexico. The purpose was to study species having storage organs. The region consists of valleys lying between abrupt limestone hills on the eastern side of the continental divide. In the valley of the Rio Salada extensive tunnels have been made by hand work for conducting irrigation waters from the strata of the valley sides. The ditches are constantly raised by deposits of lime and the fields receive lime deposits so largely that they have often been abandoned as useless. Extreme localization of floral colonies is observed here where groups are limited to a few yards of ground or to single slopes and crests. So much calcium is taken up into the pith of some of the cacti that it was gritty when chewed and so crisp as to make it difficult to express the juice. No other region, however, is on record as exhibiting the storage function so extensively as this. There are references to Oaxaca, the ruins of Mitla and the famous ancient cypresses of El Tule. At Mitla was seen the process of making mescal, "a true whiskey of a desert people," from the core of the agave.

Other regions briefly described are the Cucopa Mountains and the sagebrush deserts of the Great Basin; Death Valley; the Grand Cañon of the Colorado River; the delta of the Colorado and the Sonoran desert. In the Great Basin, succulents and storage structures were generally absent in the more northern parts and at elevations above 3,000 feet, liability to freezing being the probable reason. In the account of the Colorado delta it is asserted that contrary to persisent belief, the moist delta region has no effect on neighbouring arid districts, the relative humidity being often as low as 17 per cent. within 50 feet of the river's edge.

There is a folding sketch map of the Colorado delta, including the upper part of the Gulf of California to the southward and the Salton Sea on the north. The bottom of the latter had fortunately been examined botanically in 1903 and an expedition from the Laboratory has circumnavigated the new lake and selected stations for observing the behaviour of vegetation as the evaporating waters recede from the present shorelines. In like manner, study will be given to fringing zones of vegetation about the Pattie Basin.

A geological sketch of the Tucson region by Professor Wm. P. Blake, makes up nearly one-fourth of the text of the volume. Further topics are: the vegetation about Tucson; the temperature, water and soil relations of plants; conditions contributory to deserts; meteorology; soil; formation and extent of deserts and the influence of deserts on life. A folding map shows the chief deserts of the world and two maps in the text exhibit the conceptions of American deserts current in 1835 and 1859. The typical features of deserts are stated as inadequate rainfall, with undeveloped drainage, active wind erosion, great daily temperature range, low relative humidity, soils nearly free from humus and xerophytic vegetation. The ratio between rainfall and evaporation, rather than the absolute amount of either, determines the desert.

It is observed that gradual modifications through a long series have been shown by the study of animals but not of plants, which secure new adaptations rather by sports and saltatory derivatives. The volume closes with interesting observations on desert travel, particularly in reference to the obtaining and use of water and of the juices of desert plants. A. P. B.

**The Relation of Desert Plants to Soil Moisture and to Evaporation. By Burton Edward Livingston.** 78 pp., Diagrams, Tables, and Bibliography. The Carnegie Institution, Washington, D. C. 1906. Price, 40 cents.

The object of this monograph is the better understanding of the mode of existence of plants which thrive at the extreme limits possible to such organisms. As Alpine plants live under difficult conditions of temperature, so desert plants must survive a high degree of dryness. It is believed that basal principles in the life of plants may be more surely reached in such fields than by studies of growth in a normal environment. The researches embodied in this paper were begun at the Desert Laboratory in 1904 and completed later at the University of Chicago. The data are presented under the general division of "soil studies," "atmospheric studies" and "plant studies," and chiefly relate to conditions found adjacent to the Laboratory.

It was ascertained that the deeper layers of soil contained even at the end of the spring dry season a considerable amount of water. The real surface of evaporation lies below the surface of the ground and the moisture finds protection, since the top layers serve as a dust mulch. Certain species, after germinating, elongate the primary root rapidly and while this is going on the aërial part of the plant makes little growth. While desert plants adapt themselves somewhat to dry soils, this is not deemed "of prime importance." The physical relation of soils and water is discussed under the heads of permeability, rate of downward movement, retaining power, power of soil to raise water from lower levels and the resistance offered by the soil to water absorption by roots. Under "plant studies" we find treated,—water requirement for germination, transpiration of desert plants with numerous graphic illustrations, water requirement of certain plants, and osmotic pressure of cactus juices. The bibliography at the close of the paper includes 32 titles. A. P. B.

BRIEF MENTION.

Present-Day Conditions in China. By Marshall Broomhall. iv and 58 pp. and Maps. Fleming H. Revell Co., New York and Chicago, 1909. Price, 50c. The author, editorial secretary of the China Inland Mission, gives an outline of the great and rapid movements now taking place in the Empire. Most of the events he mentions have occurred within the past twelve or fifteen months. This little volume should be influential in stimulating intelligent interest in the history China is now making. The book also shows what foreign influences and especially missionary effort are accomplishing and the native reform movement is clearly depicted.

Het Afrika-Vraagstuk. Door Dr. C. M. Kan. 170 pp., Index and Map. H. D. Tjeenk Willink & Zoon, Haarlem, 1909. This paper, by Dr. Kan, the learned professor of Geography in the University of Amsterdam, is a concise discussion of questions and problems, from earliest times to the present day, relating to the exploration and development of Africa. We see here summarized the gradual growth of our knowledge of the physical features, climatic conditions, distribution of animal and vegetable life, etc., and the slow but enormous improvement in methods of exploration and study. The sketch map, in colours, gives a graphic idea of the progress of refined surveys, the extent and distribution of still little known regions, trade routes, railroads and telegraphs, agricultural and grazing areas, etc., and Passarge's division of the continent into natural regions. A valuable contribution to scientific geographical literature.

The Heart of Central Africa. Mineral Wealth and Missionary Opportunity. By John M. Springer. With an Introduction by Bishop J. C. Hartzell. 203 pp., Illustrations and Sketch Map. Jennings & Graham, Cincinnati, 1909. Price, $1. An account of the journey made by Mr. Springer and his wife, missionaries, across Africa from Umtali, on the western edge of Southern Rhodesia, to Loanda, on the west coast. A readable story of a remarkable trip and also instructive, for Mr. Springer had an eye for facts that would throw light upon the country and its inhabitants and resources. His route took him through the Katanga region, which is supposed to possess one of the great copper reserves of the world.

Atlantic Deeper Waterways Association. Report of Proceedings of the First Annual Convention, Baltimore, Nov., 1908. Edited by Addison B. Burke. 274 pp. The Book Print, Philadelphia, 1909. Contains many addresses on the subject of coastal and inland waterways and their development.

Die kutzowalachische Frage. Von C. A. Bratter. 186 pp. and Map. Wilhelm Opetz, Leipzig, 1907. Price, M. 1.40. Over a century ago, the people treated in this work lived in the southwestern part of Rumania, from which they emigrated to their present home, chiefly Albania but extending also into northern Greece and western Rumelia. They have had frequent troubles with their neighbours. Wide attention was attracted to them in 1905 when an irade of the Turkish government permitted them to support their own schools, use their own language in church and school and establish and administer their own local governments. The purpose of Mr. Bratter's book is to unravel the tangle of politics in this western end of Turkey so that it will be intelligible to German readers; and also to describe these sons of Rumania and show their relations to the other Balkan peoples.

Landeskunde der Vereinigten Staaten von Nordamerika. Von Prof. Heinrich Fischer. 2 Vols. I-115 pp., 22 Maps and Figures, 14 Illustrations and Index.

XUM

II-103 pp., 3 Maps in text and 1 Map in Colours, 14 Illustrations and Index. Göschen, Leipzig, 1908. Price, 80 pf. each. The "Sammlung Göschen" has at length reached our country in its little volumes dealing with regional geography. The work may be commended to German-reading Americans as an excellent example of condensed treatment of regional geography. An interesting feature is the comparison of many facts in the Old and New Worlds. Thus, in a map on which the United States is imposed upon a map of Europe-Africa, we see the central coast of California impinging upon the coast of Spain while the South Carolina coast is in Syria; and our northwestern border lies along the English Channel while the southern ends of Texas and Florida penetrate far into the Sahara. Comparative July isotherms show that New Yorkers must look to the south of the Mediterranean, in the western part of the old world, for average warmth comparable with ours in that month. The more important facts of all the geographical and economic phases of our land are logically and clearly set forth.

Illustrated Handbook of Madeira and the Canaries. By A. Samler Brown. 88 pp., 1 Plate of Maps in colours and many Illustrations. Union Castle Mail S. S. Co., London, 1906. A finely illustrated handbook for visitors to these islands.

The United States, With Excursions to Mexico, Cuba, Porto Rico and Alaska. By Karl Baedeker. 4th revised Edition. cii and 724 pp., 33 Maps and 48 Plans. Karl Baedeker, Leipzig, 1909. This edition differs considerably from its predecessors. The handbook is now used largely by American travellers at home and sections are expanded in the present edition that appeal more to the American than to the foreign tourist. Some of the maps have been enlarged and improved and there are more of them than in the earlier editions.

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## CURRENT GEOGRAPHICAL PAPERS.

### NORTH AMERICA.

CANADA.—A Forester's Work in a Northern Forest. E. Wilson. *Forestry Quart.*, No. 1, 1909.

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UNITED STATES.—Investigations relating to Clays by the U. S. Geological Survey in 1908. George C. Matson. *Bull.* 380-K., Washington, 1909.

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UNITED STATES. RAILROADS.—Une nouvelle carte des chemins de fer des États-Unis. V. Huot. *La Géog.*, No. 2, 1909.

UNITED STATES.—Contributions to the Tertiary Paleontology of the Pacific Coast. I. The Miocene of Astoria and Coos Bay, Ore. Map, 23 Plates. Wm. H. Dall. *Prof. Pap.* 59, U. S. Geol. Sur., 1909.

UNITED STATES. ALASKA.—Notes on the Point Hope Spit. E. M. Kindle. 2 Maps. *Jour. of Geol.*, No. 2, 1909.

UNITED STATES. ARIZONA.—Erosion and Deposition in the Southern Arizona Bolson Region. 3 Figs. C. F. Tolman. *Jour. of Geol.*, No. 2, 1909.

UNITED STATES. CALIFORNIA.—Absence de Traces glaciaires dans la Californie méridionale. Jiri V. Danes. *La Géog.*, No. 2, 1909.

UNITED STATES. KENTUCKY.—The Waverly Formations of East-Central ——. 2 Figs. Wm. C. Morse and A. F. Foerste. 2 Figs. *Jour. of Geol.*, No. 2, 1909.

UNITED STATES. MAINE.—Underground Waters of Southern Maine. Maps, Diagrams and Ills. F. G. Clapp and W. S. Bayley. *Water Supply Paper* 223, Washington, D. C., 1909.

## CENTRAL AND SOUTH AMERICA.

ARGENTINA.—La République Argentine. Son Développment économique, commercial, agricole et pastoral. A. Potel. *Soc. de Géog. Com. de Paris*, March, 1909.

BRAZIL.—Einwanderung und Siedlung in Brazilien. Ill. M. Schanz. *Deutsche Kolonialzeitung*, Nos. 11 and 12, 1909.

BRAZIL. INDUSTRIAL.—Die Wirtschaftslage Brasiliens. C. Bolle. *Export*, No. 14, 1909.

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BRAZIL. RUBBER.—Nochmals die Zukunft des Para-Kautschuks am Amazonas. D. Sandmann. *Der Tropenpflanzer*, No. 4, 1909.

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## NEW MAPS.

### NORTH AMERICA.

#### U. S. GEOLOGICAL SURVEY MAPS.

UNITED STATES.—Investigations of the Coal Fields of Colorado, New Mexico, Utah, Oregon, and Virginia. *Bull.* 341,-C., Washington, 1909. Illustrated by the following black and white maps, all on a scale of four miles to an inch, excepting where otherwise indicated: Western part of the Yampa coal field, Routt Co., Col.; Lower White River coal field, north of the Base Line, Col.; Lower White River coal field (reconnaissance map of Douglas Creek District), south of Base Line, Col.; Vernal coal field, Utah; part of the Henrys Fork coal field, Utah and Wyoming; Grand Mesa coal field, Col.; Coal field between Gallina and Raton Spring, N. M., in the San Juan coal region; Coal field between Durango, Col., and Monero, N. M.; Coal field between Gallup and San Mateo, N. M.; Harmony, Colob, and Kanab coal fields, Utah; Rogue River Valley and other coal fields of S. W. Oregon. Scale, about 48 miles to an inch; Sketch map of the Pocket Coal District in the Little Black Mountain coal field, Virginia. Scale, about 2 miles to an inch.

#### HYDROGRAPHIC OFFICE CHARTS.

Pilot Chart of the North Pacific Ocean, June, 1909.
Pilot Chart of the North Atlantic Ocean, May, 1909.

#### DEPARTMENT OF AGRICULTURE MAPS.

LOUISIANA.—Soil Survey of Wynn Parish, La. Scale, 1 inch=1 mile. By T. A. Caine, H. L. Belden, and L. L. Lee, Washington, 1909. With 37 pages of descriptive text.

#### U. S. LAKE SURVEY.

UNITED STATES.—Michigan. Saugatuck Harbour, Michigan. Showing New Entrance Channel. Scale, 1:12,000=0.18 mile to an inch. Supplement to Coast Chart No. 7, Lake Michigan, Detroit, 1909.

UNITED STATES.—Wisconsin. Supplement to Chart of Manitowoc Harbour, Wis. Showing latest harbour improvements. Scale, 1:8,000=0.1 mile to an inch. Supplement No. 8, to *Bull.* No. 18, Survey of Northern and Northwestern lakes, Detroit, 1909.

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UNITED STATES.—New York. Geology of the Geneva-Ovid Quadrangles. Scale, 1:63,500=0.9 mile to an inch. By D. Dana Luther. Illustrates New York State Museum *Bulletin* 128. 25 symbols in colours for geological formations.

CANADA.—Commercial and School Wall Map of the Dominion of Canada. Scale, 1:2,770,000=44 miles to an inch. W. & A. K. Johnston, Ltd., Edinburgh and London, 1909. A good wall map of Canada for school and general purposes in spite of its superabundance of political colouring. The most recent data have evidently been used in its compilation. The distribution of minerals and fishery resources and the routes of the trunk line railroads now building are shown.

## AFRICA.

ABYSSINIA.—Regione di Gulleliè-Addis Abeba. Approximate scale, 1:18,750=0.2 mile to an inch. *Boll. d. Soc. Geog. Ital.*, Ser. 4, Vol. 10, No. 4, Rome, 1909. A plan in colours of the capital town of Abyssinia; accompanies a paper "La città e il Clima di Addis Abeba," by Dr. L. de Castro.

AFRICA.—The National Geographic Magazine Map of Africa. Prepared from latest geographical data by Gilbert H. Grosvenor, Editor. Scale, 335 miles to an inch. *Nat. Geog. Mag.*, No. 3, 1909. The map emphasizes the economic aspects of Africa. In many respects a good map but with numerous inaccuracies. For example, the railroad from Lobito Bay to southern Katanga is marked completed to and beyond Bihe, which is not the case and Bihe is not on the proposed route. The Cape to Cairo railroad has been completed to Broken Hill, for many months, though not so indicated on the map. The new discovery of diamonds in German Southwest Africa is noted near Lüderitz Bay but not at Gibeon. There is no indication of the great Wankie coal field, south of Victoria Falls on the Zambezi, whose output is now sent far and wide. Furs are scarcely a representative tropical product, though the word is sprinkled in red on this map over tropical Africa. The map should be thoroughly revised if another edition is issued.

ERITREA.—Colonia Eritrea. Schizzo Ipsometrico. Scale, 1:1,500,000=23.67 miles to an inch. Brown symbols for elevations. *Boll. d. Soc. Geog. Ital.*, Ser. 4, Vol. 10, No. 3, Rome, 1909. Accompanies a paper, "Contributo allo studio geografico della Colonia Eritrea." By Capt. P. Verri.

GERMAN EAST AFRICA.—Kartenskizze Westlichen Kibo. Scale, about 1:40,000=0.6 statute mile to an inch. Illustrates "Forschungen in den Hochregionen des Kilimandscharo," by Fritz Jaeger. *Mitt. aus den Deutsch. Schutzgeb.*, Vol. 22, No. 2, Berlin, 1909.

SOUTH AFRICA.—Karte des Gebiets zwischen Okawango und Sambesi (Caprivi-Zipfel). Scale, 1:500,000=7.8 miles to an inch. After the surveys of Franz Seiner. Accompanies his paper, "Ergebnisse einer Bereisung des Gebiets zwischen Okawango und Sambesi (Caprivi-Zipfel) in den Jahren 1905 und 1906." *Mitt. aus den Deutsch. Schutzgeb.*, Vol. 22, No. 2, Berlin, 1909.

SOUTHERN NIGERIA.—Süd-Nigerien zwischen Niger und Crossfluss. Scale, 1:1,700,000=26.8 miles to an inch. *Deutsche Rundschau f. Geog. u. Stat.*, Vol. 31, No. 6, Vienna, 1909. Illustrates a paper, "Die Ergebnisse der letzten Durchforschungen von Süd-Nigerien," by Albert Bencke.

## ASIA.

ANATOLIA.—Karte des Sabandja Sees und Umgebung. Scale, 1:100,000=1.5 miles to an inch. *Pet. Mitt.*, Vol. 55, No. 1, Gotha, 1909. Illustrates a paper by C. Risch.

ASIATIC RUSSIA.—Karta Puteï Soobtschenia Asiatskoï Rossii. [Map of Ways of Communication in Asiatic Russia.] Scale, 1:4,200,000=66.2 miles to an inch. 3 sheets. Edition of 1908. Statistical and Cartographic Department of the Ministry of Ways and Communications, St. Petersburg, 1908. Price, R. 2. The map shows the present development of means of transportation throughout the Asiatic possessions of Russia. Hydrography is in blue and the head of navigation is shown on all rivers. Various symbols show post roads, great trade routes, government and provincial roads, telegraph lines, etc. The relative importance of towns is indicated by different styles of type.

PERSIA.—Geologische Karte von Nordwest-Persien. Scale, 1:840,000=13.2 miles to an inch. *Pet. Mitt.*, Vol. 55, No. 1, Gotha, 1909. Illustrates a paper, "Geologische Beobachtungen im nordwestlichen Persien," by A. F. Stahl.

## EUROPE.

AUSTRIA-HUNGARY.—Dislokation Karte der Österr.—Ungar. Wehrmacht, 1908. Scale, 1:1,800,000=28.4 miles to an inch. G. Freytag & Berndt, Vienna, 1908. Price, Kr. 3. Shows the distribution of the military forces throughout the Empire in 1908. Explanatory text and tables.

BELGIUM.—Carte de la Belgique. Scale, 1:160,000=2.5 miles to an inch. (6 sheets, edition of 1907.) Institut Cartographique Militaire, Brussels, 1907. Price, 15 frs. An admirable map of the Kingdom. Contours of elevation, with 20 meters interval; the contour line of 5 meters is also introduced to show the approximate limits of the inundation that would cover regions if the sea should break through the dikes; the expression of relief emphasized by shading, railroads and highways differentiated according to gauge of track, double or single track, material used in construction, etc.; distribution of forests, large nomenclature, etc.

ICELAND.—(*a*) Kartenskizze der Landmanna-Afrjettur. Scale, 1:120,000=1.8 miles to an inch; (*b*) Kartenskizze von Laki. Scale, about 1:12,500=0.17 mile to an inch; (*c*) Kartenskizze der Eldgjá-Spalte. Scale, about 1:27,400=0.4 mile to an inch. By Karl Sapper. Illustrates his paper, "Ueber einige isländische Vulkanspalten und Vulkanreihen." Separat-Abdruck aus dem *Neuen Jahrbuch für Mineralogie, Geologie und Paläontologie,* Band XXVI. E. Schweizerbart'sche Verlagshandlung (E. Nägele), Stuttgart, 1908. Shows in colours, lava flows, moraines, crater walls, etc.

ITALY.—Quadro d'Unione delle Levate di Campagna eseguite per la costruzione della Carta Topografica del Regno. Scale, 1:1,000,000=15.78 miles to an inch. Two sheets. Istituto Geografico Militare, Florence, June, 1907. Shows in blue the areas covered by the government topographic map on a scale of 1:100,000. Illustrates descriptive pamphlet, "Catalogo di Carte, Stampe e Libri pubblicati dall'Istituto Geografico Militare," July, 1907.

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